Vol. 9 No. 1
March 1971

SCHOOL SCIENCE

B/HL

In This Issue

Bolshoi : *A "dwarf tree culture" developed by the Japanese* Bombax Sp , *from the President's Estate*

NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

TO OUR CONTRIBUTORS

School Science is a quarterly journal intended to serve teachers and students in schools with the most recent developments in science and science methodology. It aims to serve as a forum for exchange of experience in science education and science projects.

Articles covering these aims and objectives are invited.

Manuscripts, including legends for illustrations, charts, graphs, etc., should be neatly typed, double spaced on uniformly sized paper, and sent to the Editor, **School Science,** Department of Science Education, NIE Buildings, Sri Aurobindo Marg, New Delhi 16. Each article may not normally exceed 10 typed pages.

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SCHOOL SCIENCE QUARTERLY

Vol. 9 No. 2

June 1971

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Chief Editor
M.C. PANT

Associate Editor
S. DORAISWAMI

Annual
Rs. 8.00

Single Copy
Rs. 2.00

Cover: *Technology Satellite in Orbit*—Britain's X-3 technology satellite 'Prospero' was launched to prove a variety of advanced techniques needed for communication and navigation satellites of the future.

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SCHOOL SCIENCE QUARTERLY

Vol. 9 No. 3

September 1971

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SCHOOL SCIENCE

QUARTERLY

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December 1971

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The Indian Regional Committee of the I.U.C.N. Commission on Education

INAUGURAL FUNCTION

THE Indian Regional Committee of the IUCN Commission on Education was inaugurated on 14 January 1971 by Shri T P Singh, I C S, Secretary, Ministry of Education and Social Welfare, Government of India and Secretary-General, Indian National Commission for UNESCO at the Indian National Science Academy Auditorium, New Delhi. This was held at the same time as the International Symposium on Tropical Ecology, organised by the International Society for Tropical Ecology and the Indian National Science Academy and the International Tropical Ecology Several educationists deeply interested in environmental conservation education, delegates to the symposium and members of the National Council of Educational Research and Training and the Forest Department numbering more than 200 attended the function Prof B R Seshachar, President of the Indian National Science Academy presided over the meeting It was very fitting that the inauguration of this meeting should be held at the same time as the symposium on tropical ecology, since the specialists in ecology and members

Prof B R. Seshachar, President, INSA, addressing the gathering. Shri T P. Singh, Secretary, Ministry of Education and Social Welfare (Second from left) delivered the Inaugural Address

Shri S. Doraiswami, convener and Member, IUCN Commission on Education, leading the Report Others in the picture are (left to right) . Prof R Misra, Shri T.P. Singh, Prof. B R. Seshachar and Shri R C. Soni

of the IUCN have identical interests. Prof Seshachar, a leading biologist in India, is taking a keen interest in the spread of ecology and ecological approach to the teaching of biology in the schools and colleges. Presiding over this function he laid stress on the importance of environmental conservation education, and the spread of awareness of the necessity to maintain the environmental purity among students and pupils of this country. If men were to survive from the bad effects of their own action in interfering with the balance of nature they must look up sharp and correct their ways to preserve the quality of the environment

Inaugurating the Regional Committee, Shri T.P. Singh said, that there was something wrong in industrialisation and the resultant economic and social changes, particularly after the industrial revolution when the destructive pollution of the environment became obvious Man can only be taught what nature permits him to do Man does not invent anything. It is up to man either to make use of his understanding of the natural laws for improving or damaging his environment. Conservation of the natural resources, that have enabled man to discover these important and useful principles and to apply them to improve his condition of life on this planet is, therefore, of very great importance.

The 10th General Assembly of the IUCN held a little more than a year ago in Delhi

clearly brought into focus the necessity and urgency of incorporating education for the conservation of natural resources in our school curricula The National Council of Educational Research and Training is helping many States which are now busily engaged in the development of new curricula and syllabuses and it is very opportune that the Indian Regional Committee of the IUCN Commission on Education should start its work at the present time. It is very necessary to incorporate concepts of conservation education not only in the teaching of science and technology at different levels but also to make it a part of the totality of education in all subjects. Regenerative as opposed to destructive consumption, and the preservation and improvement of the initial capital of natural resources that we have been endowed with, have to become a way of life. In no other way, is it possible to increase the standard of living of the masses without undermining, damaging and ultimately destroying the environmental capital that we are starting with, which will obviously recoil on us, sooner than we think, and completely shatter our vision of a better future. Fortunately there is still a great deal of this natural capital left in India to be preserved and added to. It is much easier to give a correct turn to education which large masses of our young generation has yet to receive.

Concluding, Shri T P. Singh said that he was impressed with the membership of the Indian Regional Committee of the IUCN Commission on Education, and he had no doubt that this Regional Committee will meet the challenge and prevent the process of damaging and depletion of our natural resources including the still unsullied mind of young people who have not yet 'learnt' to be hostile or indifferent to nature. At the end, he expressed his happiness in participating in the inauguration of this Committee and wished it all success

Earlier, Prof R. Misra welcomed all the Members of the Indian Regional Commitee, the distinguished delegates of the Symposium on Tropical Ecology and other distinguished guests who had come for the inaugural function He traced in brief the history of the genesis of the Indian Regional Committee which was the result of a decision taken at the 10th General Assembly of the IUCN He gave a brief account of the action programme decided upon by the Committee.

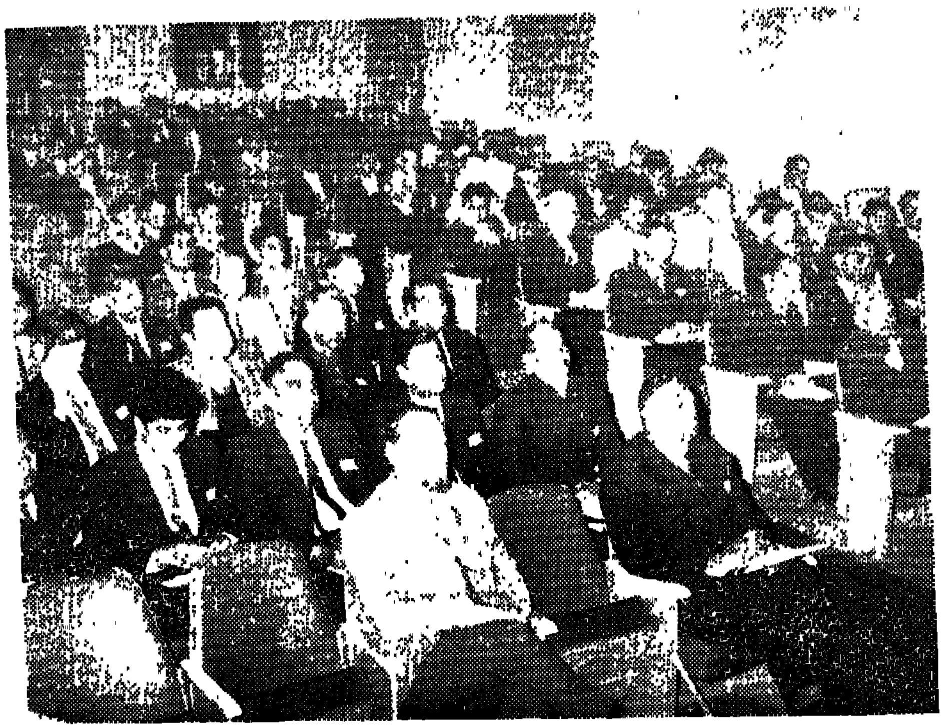
Shri S. Doraiswami, the Convener of the Indian Regional Committee, next traced the necessity felt for creating this Indian Regional Committee and also gave a brief account of what IUCN was and what its activities were for the benefit of those who were not familiar with the same He also traced the common interest of all countries in educating young pupils to appreciate and love the surrounding world of nature and strive to conserve its qualities favourable for and where possible to improve them in the interest of the present and future generations The IUCN Commission on Education plans a number of international meetings and seminars in different parts of the world to discuss problems of nature conservation to be incorporated in school curricula and textbooks The first seminar of this kind took place in June 1970 in Nevada and Shri S Doraiswami participated at the Seminar on behalf of India. The next meeting of the Commission on Education held at Sofia was attended by Prof. R. Misra. At this meeting it was decided to constitute the Indian Committee as proposed here. The members suggested consist of university teachers, specialists in forestry, educationists of the Ministry of Education and NCERT, representatives from private organisations like Bombay Natural History Society and the

Wild Life Preservation Society, and the organizer of the National Service Corp in universities Shri Doraiswami stressed the fact that every engineer, agriculturist, architect, civil engineer, economist, physician and representative of culture and business department who consider nature conservation as an integral part of his duty towards society, should be guided by its principles in his everyday work and in the planning projects. This cannot be achieved without teaching the elementary principles of preserving and rehabilitating natural resources in higher institutions like the professional colleges He also stressed the importance of creating the awareness of problems of preserving nature in out-of-school science activities of pupils and students of schools and colleges.

Dr. V.M Galushin who was representing the Chairman, IUCN Commission on Education, at this meeting expressed some difficulties which this Committee might have to face. He stressed the fact that it is more important to work for our descendents then for the present. We have to work out how to implement environmental education in the schools, colleges and universities.

A few members of the Indian Regional Committee also expressed their views about the importance of this Committee and its activities. Finally, the Convener proposed a vote of thanks to Shri T P. Singh and Prof. Seshachar for having spared their valuable time and in participating in the function. He also thanked the International Society for

(Contd. on page 15)



A view of the delegates and guests

Education for Conservation of Natural Resources

T.P. SINGH, I.C.S.

Secretary, Ministry of Education and Social Welfare, Government of India

I CONSIDER it a great privilege to associate myself with this august body, namely the International Union for Conservation of Nature and Natural Resources, and to be present here on the occasion of the inaugural meeting of the Indian Regional Committee of the Commission on Education of this world organisation.

That there was something wrong in industrialisation, and the resultant economic and social changes, has been felt instinctively by philosophers and the creators of great literature, not only after the so-called industrial revolution, when the destruction and pollution of the environment became obvious, but much earlier. In the ancient literature of my own country, technology has often been associated with evil and demoniac powers and individuals. This instinctive hostility towards technology and urbanisation was largely due to a feeling that, somehow, such developments were against nature, and that nature would have its revenge against its children who had dared to go against it. This, as a little reflection will show, resulted from lack of communication and mutual understanding between those engaged in the scientific and technological innovation, and the rest of the population, specially the scholars and intellectual leaders who had confined their study and research to religion, philosophy, literature and the fine arts. When we come to think of it, there is no meaning in the word 'artificial'. Man can only do what nature permits him to do. Man does not invent anything. He makes discoveries of principles operative in nature and often finds ways of generalising those principles and reapplying them to the task of changing the human environment and mode of life, in a spectacular manner However, there is nothing artificial, in the sense of being against nature, in any part of this process. Nature has to permit all that man is able to do. It is up to man, either to make use of his understanding of natural laws, for improving, or damaging his environment. Conservation of the natural resources that have enabled man to discover these important and useful principles, and to apply them to improve his condition of life on this planet is, therefore, of very great importance.

The 10th General Assembly of the IUCN held a little more than a year ago, in this city, clearly brought into focus the necessity and urgency of incorporating education for the conservation of natural resources in our school curricula. The urgency of doing this is obvious if the need to make the fruits of the technological revolution available to all mankind, instead of to a minority only, as here-to-fore, and the rapid increase in the number of human beings on

Inaugural speech delivered on 14 January 1971 at the Indian National Science Academy, New Delhi.

this planet, are considered. Whatever is there in nature, whether it be any species of plant or animal, or any area of land or water, that has not been put to any productive or beneficial use so far, may yet prove of very great value, as we go along The earliest available Indian prayers, in the Vedas, are addressed not only to the great and powerful Gods, but also to the Earth, to mountains and masses of water, and to plants The mythological and religious literature of the great ancient civilisations of all races and tribes refers to the Divine Beings having assumed the form of various animals. This should itself be taken as an index of the instinctive understanding by great and wise people, since the dawn of human civilisation, of the importance of the natural environment, in all its aspects To go back to ancient sources while discussing modern problems is not, always, obscurantism. Those who "know" have always clearly distinguished between knowledge and wisdom. The storehouse of human knowledge has lately increased tremendously, but is any knowledgeable person sure that "wisdom" which the poet Tennyson likened to the elder sister of knowledge has also advanced, correspondingly.

Many of the States in India are now busily engaged in the development of new curricula and syllabuses, for various disciplines, in their schools. The National Council of Educational Research and Training is helping in this process, specially so far as the teaching of science in schools is concerned. It is indeed opportune that the Indian Regional Committee of the IUCN Commission on Education is starting its work at the present time, so that with the help of educationists and conservation specialists in our country, we are enabled to incorporate environmental conservation, in an appropriate manner, in the teaching material and methods used in our educational system I understand that the Jawaharlal Nehru University has already decided to start a Department of Environmental Science, and many universities in India have established schools of ecology in their faculties. It is necessary to incorporate conservation education, not only in the teaching of science and technology at different levels, but also to make it a part of the totality of education in all subjects. Regenerative as opposed to destructive consumption and the preservation and improvement of the initial capital of natural resources that we have been blessed with, have to become a way of life In no other way is it possible to increase the standard of living of the masses, without undermining, damaging and ultimately destroying the environmental capital that we are starting with, which will obviously recoil on us, sooner than we think, and completely shatter our vision of a better future. Fortunately, there is still a great deal of this natural capital left in India, to be preserved and added to. Also, the tardy progress of education at the primary and secondary levels so far is itself an advantage, because it is much easier giving a correct turn to the education which large masses of our youth have yet to receive, then it would have been to make basic changes in a fully developed and set educational pattern covering the entire population. It is much easier doing something right the first time, than trying to do it right after having got used to doing it the wrong way, for a long period of time

I have been greatly impressed with the membership of the Indian Regional Committee of IUCN Commission on Education, and I have no doubt at all that this Regional Committee will meet the challenge, and prevent the process of damage to and deple-

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Indian Regional Committee of I.U.C.N. Commission on Education

S. DORAISWAMI

Member, IUCN Commission on Education

REPORT

MR Chairman, distinguished delegates and fellow members of the Regional Committee of the IUCN Commission on Education At the outset I am very happy to welcome you all for this meeting which has been convened as a sequel to the IUCN General Assembly held at New Delhi in December 1969 At this Assembly three members from India were elected to the Commission on Education, viz., Prof. R. Misra, Shri R.C. Kaushik and Shri S Doraiswami

It will not be out of place to give a brief account of what is IUCN for such of those who may not be familiar with this organisation The International Union for Conservation of Nature and Natural Resources (IUCN) was founded in 1948 with headquarters in Switzerland. It is an independent international organization whose membership consists of States, governmental and private organisations and international groups. It represents those who are concerned at man's alteration of natural environment through the rapid urban and industrial development and the excessive exploitation of earth's natural resource upon which rests the foundation of its survival.

The IUCN promotes an awareness through education so that as many people as possible may understand the value and the importance of renewable natural resources and appreciate the need to use them wisely. Activities of this organization include General Assembly meetings, Regional Meetings, symposia and the dissemination of information through press, radio, films, television and through publications.

Organization of IUCN

The IUCN operates through a number of Commissions and Committees, each of which specialises in different aspects of the Union's work. Among these committees is the Commission on Education which is primarily responsible for the educational aspects of the Union's work and acts as a clearing house for educational material relating to the conservation of nature and natural resources. Several Regional Committees have been set up to this Commission to ensure that its activities take effective account of local conditions and needs. Such committees are the East European Committee, the Latin American Committee, and so on.

Since its establishment the Commission has promoted and supported action in the field of conservation education throughout the world. It has become the centre in this field and the principal consultative body of IUCN and other International organizations like the ICC.

The 10th General Assembly of the Council

which took place in India in December. 1969 recommended that the Commission on Education shall intensify its work in explaining in different countries and international agencies, the growing significance of man's attitudes towards this natural environment, the aims and methods of rational use of natural resources taking into account his versatile needs of them. To this end it will aid in implementing a wide system of conservation education which would include:

(*a*) Teaching subjects of nature conservation in educational institutions at all levels.

(*b*) Specializing in nature conservation and in matters of preservation and rehabilitation of certain natural resources in higher and secondary educational institutions.

(*c*) Organizing out-of-school nature conservation work amongst students.

(*d*) Doing propaganda on nature conservation among various strata of society.

In recent years many nations have undertaken certain efforts to make school children learn more of the tasks of nature conservation, make them care for their natural environment, plant and animal kingdom, acquire practice of work in conserving and rehabilitating natural resources. In India too, many States are now in the act of innovating their curricula to bring them on modern lines.

Each country, depending on its natural conditions, historical development, social system and traditions in nature conservation may have its own forms and methods of educational work. Still there is much in common like the foremost aim being to educate a young man who appreciates and loves the surrounding world of nature and strives to conserve its quality favourable for and where possible to improve them in the interests of the present and future generations. The Commission among other things plans a series of seminars in methods in different regions of the world whose aim will be the exchange of experience and elaboration of suggestions concerning the inclusion of subjects of nature conservation in school curricula and textbooks The first seminar of this kind took place in June 1970 in cooperation with the Forestal Institute, headed by Prof. R Miller (Nevada, U S.A.) This seminar not only formulated some concepts of environmental education which was multi-disciplinary in approach, but also made several recommendations for implementing the programme of environmental conservation education. These recommendations may be found in some documents being distributed. The Ministry of Education, the Government of India had nominated me to attend this working meeting at Nevada. It is proposed to convene a meeting of curriculum makers of NCERT and a few representatives of the States in the near future to adopt/adapt these concepts to suit our educational structure. It is hoped that much of these would be incorporated within the framework of our present curriculum without overloading it very much.

Another meeting of the Education Commission was held later at Sofia (in October) and this was attended by Prof. R. Misra. At this meeting it was decided to constitute the Indian Committee as proposed today and several experts and persons interested in conservation education have been nominated to the committee. It consists of university teachers, specialists in forestry, educationists from the Ministry of Education and NCERT, representatives from private organizations

like Bombay Natural History Society and the Wild Life Preservation Society and organizer of the National Service Corps in universities.

It is a good augury that the first meeting of the Indian Regional Committee should be held along with the symposium on organic productivity in the tropics being organized by INTECOL, ISTE and INSA. After all, conservation of nature is very much an ecological approach

It was very kind of the International Society for Tropical Ecology to have given us the facilities and the opportunity to hold this inaugural meeting in the presence of the distinguished delegates of this symposium on tropical ecology. I am also very grateful for the willingness with which Shri T.P. Singh, Secretary, Ministry of Education, has agreed to inaugurate this Committee This Committee reflects the interest and importance attached to the problem by the Government of India and particularly the Ministry of Education in furthering the aims of the education programme of IUCN among the schools and colleges and among the youth activities.

Higher Education

Nature Conservation Education is a problem not limited to primary and secondary schools Certain problems are not appreciated by those who decide on policies and who are decision makers. In such conditions educational work in nature conservation takes an important meaning in training specialists in professional schools and colleges. Each engineer, agriculturist, architect, civil engineer, economist, physician, representative of culture and business department, every one is obliged to consider nature conservation as an integral part of his duty towards society and should be guided by its principles in his everyday work and in planning projects. This cannot be achieved without teaching the elementary principles of preserving and rehabilitating natural resources in higher institutions like the professional colleges.

I do hope that we in this committee would be having the cooperation of all the learned ecologists here.

Speech by Dr. V. M. Galushin

Dr. V.M. Galushin, representative of the Chairman, IUCN Commission on Education, congratulated the newly elected members of the Indian Regional Committee and wished them all success. He expressed some difficulties which would be met by the Committee The main difficulty is originated from the essence of the movement for conservation of nature itself. It is an actual contradiction between today and tomorrow between present time and future, between us and our grand-grand-children. The second difficulty is originated from young age of environmental education, today it is still little known; how to introduce environmental education in curricula; how to implement it properly in schools, colleges and universities, etc.

In our work we should remember those and other difficulties in order to find proper ways to overcome them. And more; we should clearly understand that our efforts are practically useless for us personally. We should think of future, we should work for our descendants. That should be our way of thinking and our philosophy. Our main aim is to sow its seeds into souls of youth in order to make their way of thinking, their philosophy and their mode of life. It is not easy, but it is noble.

First Business Meeting—15 January 1971

On 15 January 1971, first business meeting of the Regional Committee was held with Dr V M. Galushin in the chair The first item to be transacted was the election of the Chairman of the Committee. Only a member of the main Commission on Education of the IUCN could be elected as Chairman. Shri S. Doraiswami who had already done spade work for the establishment of the Indian Regional Committee was unanimously elected Chairman and Col. Dayal and Prof. Pandeya were elected Vice-Chairman. The Chairman was given the freedom to co-opt the Secretary later as the necessity arose. Dr Galushin after congratulating the newly elected Chairman and Vice-Chairmen, vacated the Chair and requested Shri Doraiswami to preside over the rest of the meeting.

Prof. Misra narrated the activities of the Banaras Hindu University which had already experimented in a small way in four of its Departments a project on conservation as extension of education. He agreed to circulate the necessary papers and documents to the members. One of the National Integration Camps to be conducted by Banaras Hindu University may take up this subject at a symposium during the next financial year.

The resolutions passed at the Working Meeting of 1969 and those passed at the Working Meeting in June 1970 at Nevada, and those passed at the Sofia Meeting in October 1970 were considered and endorsed by the Indian Regional Committee.

The members were asked to prepare certain projects with (i) title, (ii) aims and objectives, (iii) action proposed and (iv) results anticipated. One of the projects adopted was that suggested by Prof. K.C. Misra. Members were requested to communicate their projects to the Chairman.

I. U. C. N.

The International Union for Conservation of Nature and Natural Resources (IUCN) was founded in 1948 and has its headquarters in Morges, Switzerland. It is an independent international organisation whose membership consists of States, governmental and private organizations and international groups. It represents those who are concerned at man's alteration of natural environment through the rapid urban and industrial development and the excessive exploitation of earth's natural resources upon which rests the foundation of its survival.

Objectives of IUCN

The main purpose of the IUCN is to promote or support action which will ensure the perpetuation of wild nature and natural resources on a global basis. To further these objectives, among other things, the Union promotes an awareness through education so that as many people as possible may understand the value and the importance of renewable natural resources and appreciate the need to use them wisely. Activities of this organization include General Assembly meetings, Regional meetings, symposia and the dissemination of information through the press, radio, films and television and through publications

Organization of IUCN

The IUCN operates through a number o commissions and committees, each of which specialises in different aspects of the Union's work. Chairmen of Commissions are appointed by the General Asssembly, members are appointed by the Executive Board on the recommendations of the Commissions.

Commissions on Education

Among the several commissions it has established, the Commission on Education is primarily responsible for the educational aspects of the Union's work and acts as a clearing house for educational material relating to the conservation of nature and natural resources The Commission uses the press, radio, films and television for advancement of Conservation Education The Regional Committee has been set up to ensure that its activities take effective account of local conditions and needs

Since its establishment the Commission has promoted and supported action in the field of Conservation Education throughout the world and thus has become the world centre in this field and the principle consultative body of IUCN to UNESCO and other individual organizations It has held some successful workshops and symposia in Nairobi (1963), Bangkok (1965), Lucern (1966)and Bariloche (1968) The Commission on Education is publishing a *Newsletter* with the view that it will enable educators, scientists and other specialists to receive information about the recent work of the Commission and its Regional Committee and that it will contribute to the development of an exchange of information on Environmental Education in different countries.

The IUCN has always considered its Commission on Education as one of its important bodies This is mainly because of the inter-disciplinary role of education integrating all the components of nature conservation and interpreting its scientific basis as well as practical matters both to the general public and recent and future specialists in different fields.

At the 10th General Assembly meeting, on December 1, 1969, the Executive Board of IUCN elected three Indian members, namely Prof. R. Misra, Shri S Doraiswami and Sri R C Kaushik to the IUCN Education Commission These three members have been requested to constitute an Indian Regional Committee of the Commission on Education of the IUCN to carry on the work of Education Commission in India and later expand to include some neighbouring countries The three members have met already a few times and they have drawn up a programme of work and expansion of the Commission since the Delhi meeting. There have been two working meetings of the Education Commission, one at Nevada and another at Sofia in Bulgaria The last meeting of the Education Commission at Sofia brought out the following developments

I. The decision to enlarge the present Indian Committee by bringing in the following membership.

(1) Four University Teachers from North, South, West and East regions of the country interested in Ecology/Nature Conservation/Environmental Science.
(2) Two teacher organisers of the National Service Corps in universities.
(3) The President of Forest Research Institutes and Colleges, Dehra Dun
(4) Four Forest Officers from different regions known for their interest in education/organisation.
(5) One nominee each of the Ministries of Agriculture and Education.
(6) One nominee of the Bombay Natural History Society or its President.
(7) One nominee of the Wild Life Assoicaciation of India.
(8) Three present Members of the IUCN Education Commission already elected by the Executive Board of IUCN.
(9) Shri S. Doraiswami to be the convener of this group and set up a secretariat at his place of work.

II. The employer organisations of the members shall be approached to meet the cost of the travel for attendance at the meetings.

The inaugural meeting of the enlarged Committee was held at New Delhi on January 14, 1971, at the time of the Symposium on organic productivity in the topics organized by INTECOL, ISTE and INSA.

The following members were unanimously elected to the Indian Regional Committee of the IUCN Commission on Education.

List of Members

1. Dr R.S. Ambasht,
Reader in Botany,
Banaras Hindu University,
Varanasi.

2. Shri S.R Chaudhari,
Senior Research Officer (Wild Life),
Indian Forest College, F.R.I College,
P.O New Forest,
Dehra Dun.

3 Dr. H.C. Day,
Director of Forest Education,
Forest Research Institute and College,
P O. New Forest,
Dehra Dun.

4. Col. P Dayal, (*Vice-Chariman*)
Director General NFC,
Ministry of Education,
New Delhi.

5 Shri S Doraiswami, (*Chairman*)
Member, IUCN Commission on Education,
Reader, Department of Science Education,
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Resolutions on Education Adopted by the Tenth General Assembly of IUCN, New Delhi, 1 December 1969

Teacher Training

THE Tenth General Assembly of IUCN meeting at New Delhi in November 1969 appeals to Governments that teacher training for primary and secondary schools should include environmental education, of which the training in field-work ought to be a vital part, and that all fields of biology teaching at universities and teacher-high schools should include practical training in organising field-work, and further appeals to all relevant bodies to provide didactic material and financial aid wherever these are urgently required

Pollution and Education

The Tenth General Assembly of IUCN meeting at New Delhi in November 1969 *considering* the growing threat to the environment caused by pollution, *recognizing* that many well documented features of environmental pollution provide an insight into the characteristic of ecological inter-relationships, *urges* that the attention of teachers at all levels of education be drawn to environmental pollution, and *recommends* that they be urged to find means by which pollution matters could feature in their lesson plans and teaching programmes, and *further recommends* that special effort be directed towards the conservation education of professional people, in public service and private sectors, whose decisions are the basis for community affairs and development with regard to the environment, and that problems of environmental quality and of environmental pollution be included in the syllabi for education and professional training of industrial chemists, medical and pharmaceutical suppliers and associated professions, foresters, agriculturalists, civil engineers, landscape designers, and planners and other resource-linked professors.

School Education in India

Considering the deterioration of the human environment in India, as in the rest of the world as a result of disturbance of nature and depletion of the natural resources; *recognizing* the urgent need for introducing and intensifying appropriate methods of conservation education at all levels, *considering* that conservation education should become a part of the curriculum of all schools, *being aware* of the pressing need for an ecologically oriented method of education in the teaching of biology and other subjects, the 10th General Assembly of IUCN meeting at New Delhi in November 1969 urges national authorities on education, educational organizations and other similar bodies engaged in the revision of curricula and syllabuses in all States to take into consideration the importance of conservation education and include concepts of these topics in the syllabuses in biology, physics, chemistry, geography, social sciences and other related disciplines, and to

1 Prepare teaching aids including suitable textbooks, teacher guides and supplementary materials based on the syllabuses and audio-visual aids like charts, models of animals in danger of extinction, film-strips and films,

2. Include teaching in the classrooms to follow methods involving environmental studies so that an awareness of the role of nature is created in the pupil,
3. Train a core of teachers through short courses in conservation and environmental concepts to form the leaders in their respective areas and act as resource-specialists to train further batches of teachers;
4. Encourage the appropriate authorities to develop systems of incentives for teacher-participation in in-service courses, of conservation education;
5. Organize workshops, seminars and other training activities for teachers who are responsible for environmental education,
6 Organize out-of-school activities through such organizations as Young Naturalist Societies which should be encouraged to undertake excursions and summer camps to study nature and nature conservation,
7. Set up a working group as Action Committee to guide workers on conservation education; to include university teachers, central educational organizations and State Departments of Education and representatives of voluntary organizations engaged in nature conservation activities,
8. Make full use of available assistance offered by inter-governmental and non-governmental organizations for those nature conservation education programmes that would gain in strength and scope through such action.

It further recommends that an Indian Committee of IUCN's Commission on education be set up to maintain the activities and the follow-up in the States

Youth and Conservation

In view of the rapidly increasing interest among young people of many countries in the problems of the natural environment, *considering* that for the future of IUCN and for the future of the national use development of the world's natural resources this growing interest should receive wider support and encouragement from conservationists, and *in view* of the dimensions of the world population increase and the fact that more than half of the present population is under 25 years of age, the 10th General Assembly IUCN meeting at New Delhi in November 1960 *resolves* that

1. IUCN consider the active promotion of out-of-school conservation education programmes for young people, especially through its Education Commission and in cooperation with the International Youth Federation for Environmental Studies and Conservation;
2. IUCN should endeavour to persuade its member states, organizations and international agencies with which it is associated to
   a) encourage the participation of young people in the decision process, as well as action programmes in the sphere of conservation of natural resources;
   b) assist young people to organize their own projects and programmes of action such as work camps, study camps, courses and conferences, both nationally and internationally,
   c) encourage the establishment of youth conservation programmes in

developing countries to assist in the integration of an ecological approach into the community development process

International Cooperation in Education

One of the urgent problems in the field of environmental education is the proper integration and coordination of all activities, developing or planned It is necessary to make relevant surveys on a serious research basis to prevent overlapping by various authorities, organizations, centres, institutes and other bodies, to discover the gaps in the whole systems and programmes of environmental education and to make efforts to fill in those gaps The Tenth General Assembly of IUCN meeting at New Delhi in November 1969 *therefore urges* early establishment of an "Inter-Agency Working Group on Education" recommended in Resolution No. 13 from the Biosphere Conference, is a task of high priority The international agencies and organizations concerned are requested to create such a group as soon as possible.

(*Contd from page 4*)

Tropical Ecology and the Indian National Science Academy for having provided the facilities for holding the meeting He thanked the members who were present in large numbers, and looked forward to a happy period of cooperation in this common task of preservation of nature and spreading the principles of environmental conservation education.

Shri Kaushik had expressed his inability to attend the function, but extended his wholehearted cooperation in the venture. Shri S.R Chaudhari, Dr. H C. Day, Dr. A.M Mahmood Hussain, Dr. R.N. Misra and Shri Hari Dang could not be present All the other members were present.

S DORAISWAMI
Chairman

(*Contd from page 6*)

tion of our natural resources including the still unsullied mind of our young people who have not yet "learned" to be hostile or indifferent to nature I am very happy to participate in the inauguration of this Committee, and I wish it all success.

Ecology in Kindergarten

As elsewhere, there is widespread concern in Europe about the threat to the environment An international conference held in 1968 was devoted entirely to the question of how to preserve life in all its forms Although the conference lacked the powers of enforcement, it did recommend certain steps and procedures, and it decided to make the year 1970 a focal point of a publicity campaign. Thereupon the Council of Europe went one step further by declaring 1970 "Nature Conservation Year" The Ministerial Committee appealed to all members to alert the nations to the grave dangers threatening our environment

Holland, with its high population density and advanced industrialisation is potentially most vulnerable It heeded the call by translating it into its own idiom. The commission instituted to take the matter in hand, studied the question of publicity and then went as far as insisting at such publicity that begin with children of kindergarten age. They pointed out that to an urban child, especially, nature is a far-away and often completely unknown quantity Therefore, kindergarten teachers are asked to take nature right into the classroom in order to show its wonders to the four-to-six-year-old set. This is achieved by very simple means. The tots are encouraged to water plants in the classrooms; they are shown how to germinate beans on a wet sponge so that they may watch them sprout and develop tiny leaves. Stories about nature are featured above all others, and the kids make drawings and are shown pictures.

In the primary schools, pupils are given nature calendars showing the various stages of development occurring during the course of the year. They study special lecture notes on such topics as "The Water," "Our Coast"—subjects close to inhabitants of a waterlogged country The children are shown how lakes and waterways get polluted, and what pollution does to man and wildlife. They are also told what can be done about it. The workings of water purification plants are explained, and the children learn that they are very costly and therefore all too thinly scattered. The lecture notes urge young readers never to forget about water purification plants, and to press the Government into building more and more of them when they are grown up. This is typical of the Dutch Here is an invitation to rebuke the every authorities who put out the notes in the first place!

The nature conservationists, who have been at it longer than most, have also stepped up their activities, aimed at showing young people that conservation is more than putting a fence around a piece of scenery Organizing camps for people between the ages of 15 and 30, they go out on the moors and chop trees, which is essential if the moors and marshes are to be preserved for wildlife and posterity. Apart from the educational value of these camps, the free help is welcome as conservation is notoriously poor and understaffed. The young campers

for their part discover that conservation is man's only chance of living in decent natural surroundings, and that if the destruction of nature is left to go unchecked, mankind is bound to disappear as wildlife is doing now with alarming speed.

This Nature Conservation Year is running its course in the Netherlands, as far as the young are concerned, at least. And it isn't likely to stop at 12 o'clock midnight, December 31st either. It's in the air, polluted as this element may be, and next year's kindergarten crop is sure to get a whiff of it, too.

By Courtesy: Radio Netherlands

Conservation of Natural Resources

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MOST of the problems which we face today stem from unchecked growth of human population and massive industrialization which is accompanied by environmental deterioration. It is now generally realized that the ultimate well-being of mankind hinges upon ecological conservation of our finite natural resources. World over newspapers, magazines and journals are devoting increasing space to highlight the undesirable effects of environmental degradation. In this connection 'Conservation', 'Natural Resource', and 'Ecology' are familiar terms to most of us yet their meaning and importance have escaped many. The purpose of this article is to define these terms and explain as to why they are assuming an ever increasing importance in our civilized world.

What is Conservation?

Unlike most words, the term conservation has undergone considerable 'evolution'. It does not carry the same connotation to all Whatever the source of interest, in simple terms it means 'frugality' or wise use to insure maximum present and future benefit from the available resources. It does not necessarily mean "locking up" or saving resources. For example, if we stop harvesting mature trees from a commercial forest, they will eventually die, fall and decompose. Thus it would be wasteful. It would be good conservation to harvest the trees for our present use, and encourage the growth of new trees for future use.

Multiple-use is a term applied to a management programme giving attention to two or more uses of a natural resource at the same times.

Often, conservation practices give rise to heavy emotional involvement because they tend to balance the natural resources against human needs. Such a situation necessitates an appraisal of the resources and their judicious exploitation to meet the aesthetic and utilitarian needs of man.

Natural Resource Concept

Natural resources include everything of natural origin living and non-living which human beings use and enjoy. They povide the base for industrial development and modern civilization. They include air, sunlight, soil, water, space, natural landscape, minerals, forests, plants and animals.

To quote Held and Clowson: "A natural resource is only quality or characteristic of nature which man knows how to use economically to ends which he desires." As we look at resources themselves, it is obvious that they fall into two distinct categories—those which are comprised of plants and animals, and those which are non-living or minerals. The first group of resources have the capacity to renew themselves through the process of growth and reproduction if managed wisely. The second group of resources have no such

power. They are minerals, such as iron ore, or non-living organic substances, such as oil and coal This group represents a sort of fund in which the maximum amount that would ever be present was fixed prior to man's exploitation, and is being constantly diminished over the years as man uses them up These two classes of resources have been called renewable and non-renewable resources With any thought it becomes apparent that it is impossible to manage these two classes of resources in the same manner. Further, all the resources are interconnected and their rational use will be difficult without a proper appreciation of the interrelationships They can be utilized wisely for our present needs and still be available for use and enjoyment by future generations. Absence or restricted supply of any of these will have serious adverse effect on our social, economic, and technological advancement.

Population explosion, rapid urbanization, expanding industries, and mechanized agriculture have combined to alter dramatically our pattern of land use and to impose ever increasing demands upon our resource base. Man's ever increasing assault on the environment, under the pressure of the swelling population, is changing the land, the water, and the atmosphere, in ways he intends and often in ways he does not intend This calls for an urgent action to counter the accelerated squandering of our natural heritage.

Ecology

The term ecology is derived by combining two Greek Words Oikos (=house) and Logos (=Study). Ernst Haeckel, a German biologist, in 1866 defined it as the "body of knowledge concerning the economy of nature, the investigation of the total relations of the animals to its inorganic environment" Fredric E. Clements considered ecology to be the science of the community. Recently, Professor Eugene P Odum, an American ecologist, has defined it as the "study of the structure and function of nature". Regardless of the actual recipe of its definition, it is relatively a broad-based subject, which cuts across many diverse fields of study.

The discipline of 'Ecology' deals with the interrelationship of living organisms and their environment, which means a vast complex of factors including all resources. The *ecological viewpoint* is of utmost importance in the era of population explosion where certain environmental conditions will exert a degree of concern which man has never experienced before. Water is one such factor which is rapidly becoming "limiting' throughout the world. Study of watersheds and their ecological management is of great importance specially in a country like ours, where agriculture depends directly or indirectly on rainfall. A detailed study of vegetation and its manipulation can improve the damaged watersheds and help to ensure safe and regular supply of water Modern civilization is, in many ways, a wasteful civilization since it thrives by expanding the energy stored, in the geological past, in the form of fossil fuel. It is the inherent character of the present civilization to generate massive amounts of waste Pollution of air, water and soil is increasing with the expanding technology and industry. Pollution of these basic resources will have unpredictable, and surely unmanageable, consequences on the ecosystem of which man too is an integral part

Some problems of population and some problems of natural resources can be studied in isolation, but the interactions are so intimate that they must be studied together. The ecological viewpoint of conservation is the intergrated view of man's environment, stressing the interdependence of all its parts.

All of us must take due interest in the conservation of natural resources, since it is a matter of preserving life and ensuring bright future of mankind. An understanding of the relationship between natural resources and different ways for utilizing them will help us make wise decisions. We will be in a better position to sort facts from opinions. The land, with its water, forests and wildlife, provides us with enjoyment and opportunities for outdoor recreation. Man needs solitude, dignity, beauty and space provided by nature for his fullest development. He will need them even more as populations everywhere increase, open land disappears, and natural areas become even more crowded.

Theorem of Pythagoras—Its Different Proofs

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ALMOST all secondary school teachers of mathematics are aware that many proofs of Pythagoras Proposition have been developed. Irving Adler in his book *A New Look at Geometry* mentions of a book by Elesha Scott in which there are as many as 256 different proofs. It indicates the keen interest taken by the mathematicians of different ages in the theorem No wonder that many other proofs can also be developed by mathematicians of future because the algebraic and geometric relations implied in the theorem and its applications are so many. Every one is acquainted with the too long usual proof of the theorem given in our textbooks.

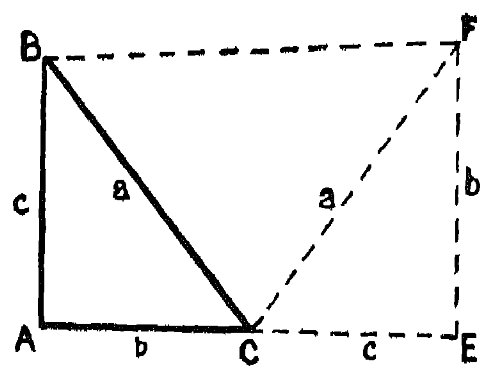
The following seven proofs are given with a view to encourage the student to discover (or rediscover for himself) certain facts in mathematics, which will definitely enhance his interest in mathematics. This discovery approach to the subject will help create true mathematicians and it is not very difficult. It requires an elementary knowledge of the subject together with the normal curiosity and insight possessed by many a students studying in our higher secondary schools

Needless to say, that some of these proofs of the theorem so far discovered are quite simple and may replace even the usual text-book-proofs for the purpose of teaching in the classroom, but some others are definitely meant for the brilliant students only The decision ultimately depends upon the individual teacher who can utilise or reject any of these, considering the age and stage of his students, he is supposed to deal with in the mathematics clubs.

Only the outlines of the proofs are given below.

First Proof

Take a triangle ABC right angled at A; As usual, we mark $AC=b$, $AB=c$; $BC=a$. Produce AC to E such that $CE=c$ and at E draw $EF \perp CE$ such that $EF=b$. Obviously $\triangle ABC$ and $\triangle ECF$ are congruent and $CF=a$. Also $\triangle BCF$ is a right angled triangle right angled at C.



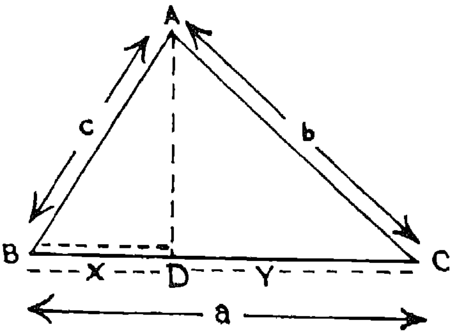
Now area of Trapezium AEFB = Area of $\triangle$ ABC + Area of $\triangle$ BCF + Area of $\triangle$ CEF.

$\therefore \quad \frac{1}{2}(b+c)(b+c) = \frac{1}{2}bc + \frac{1}{2}a.a. + \frac{1}{2}c.b.$

$\therefore \quad (b+c)^2 = 2bc + a^2$

$\therefore \quad b^2 + c^2 = a^2$

Second Proof



Consider the $\triangle$ ABC right angled at A. Now with the usual notations we mark sides AB, BC, CA as shown in the figure. Draw $AD \perp BC$ Let $BD = x$; $DC = y$ so that $BD + DC = BC$ or $x + y = a$. In the diagram, we have three similar triangles:

(i) $\triangle$ ABD and $\triangle$ CBA are similar;

(ii) $\triangle$ ACD and $\triangle$BCA are similar.

$$\therefore \quad \frac{BD}{BA} = \frac{AB}{BC} \text{ and } \frac{CD}{AC} = \frac{AC}{BC}$$

$$\therefore \quad \frac{x}{c} = \frac{c}{a} \text{ (BD} = x\text{)}, \frac{y}{b} = \frac{b}{a} \text{(CD} = y\text{)}$$

(Replacing each line-segment with corresponding algebraic length as shown in the diagram.)

$\therefore c^2 = ax \quad . \quad$ (i), $\quad b^2 = ay \ldots\ldots$ (ii)

Adding (i) and (ii) we get

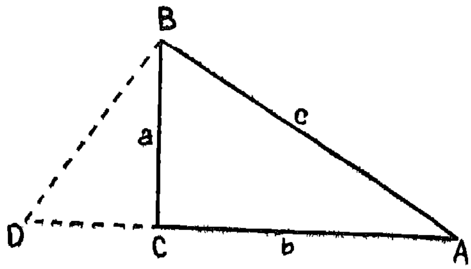
$\therefore c^2 + b^2 = a(x+y)$

$= a\,a$

$= a^2$

Third Proof

Consider $\triangle$ABC right angled at C. We extend AC to D such that $\triangle$ABD is right angled at B Now obviously,



$\triangle$BDC, $\triangle$ABC and $\triangle$ADB are similar. Let A_1, A_2, A_3 respectively denote areas of $\triangle$s BDC, ABC and ADB.

$\frac{A_1}{A_2} = \frac{a^2}{b^2}$ (Areas of similar $\triangle$s are in the ratio of the squares of corresponding sides.)

$\frac{A_1 + A_2}{A_2} = \frac{a^2 + b^2}{b^2}$ (i)

Also

$\frac{A_3}{A_2} = \frac{c^2}{b^2}$ (ii) (From $\triangle$s ADB and ABC)

But $A_1 + A_2 = A_3$ (iii) (Sum of the parts = the whole)

From (i, (ii) and (iii) we have

$\frac{A_3}{A_2} = \frac{a^2 + b^2}{b_2} = \frac{c^2}{b^2}$

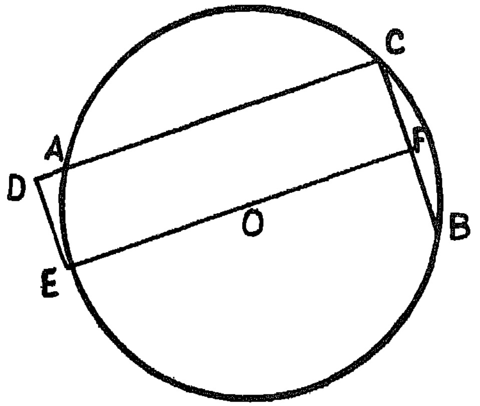
$\therefore \quad a^2 + b^2 = c^2$

Fourth Proof

We know that angle in a semi-circle is a right angle. Consider $\triangle$ABC with AB as diameter of a circle whose centre is O. Draw FOE parallel to CA; from E drop $ED \perp CA$ produced to meet it in D. Obviously, FCDE is a rectangle and F is the mid point of BC. As usual we denote

that AB = c, BC = a and CA = b.

$$DE = FC = \tfrac{1}{2}BC = \tfrac{1}{2}a, \quad DC = EF = EO + OF = \frac{c}{2} + \frac{b}{2}$$



$$AD = CD - AC$$

$$= \left(\frac{c}{2} + \frac{b}{2}\right) - b = \frac{c}{2} - \frac{b}{2}$$

Now DE is a tangent and DAC is the secant from D. (ED $\perp$ dia EOF)

$$\therefore DE^2 = DA\ DC$$

or $\left(\frac{a}{2}\right)^2 = \left(\frac{c}{2} - \frac{b}{2}\right)\left(\frac{c}{2} + \frac{b}{2}\right)$ (Putting the values of DE, DA and DC)

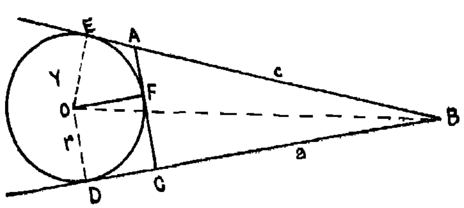
$$\frac{a^2}{4} = \frac{c^2 - b^2}{4}$$

$$\therefore a^2 = c^2 - b^2$$

$$\therefore a^2 + b^2 = c^2$$

Fifth Proof

Consider $\triangle$ABC right angled at C. Let O be the centre of the excircle opposite to angle B and r be its radius. Let E, D, F be the points of tangency. Now with the usual notation we denote AB = c, BC = a, AC = b.



We have AE = AF = AC − FC = b − r($\because$ FC = OD = r as OFCD is a square)

BD = BC + DC = a + r, BE = BA + AE = c + b − r.

Obviously $\triangle$BOE and $\triangle$BOD are congruent and as such equal in area.

Area of $\triangle$ BOE = $\frac{1}{2}$r (b + c − r)

and Area of $\triangle$BOD = $\frac{1}{2}$r (a + r)

$$\therefore \tfrac{1}{2}r(b + c - r) = \tfrac{1}{2}r(a + r)$$

$$\therefore (b + c - r) = a + r$$

$$b + c - a = 2r$$

$$\frac{b + c - a}{2} = r \qquad (1)$$

Now Area of $\triangle$ABC = 2 area of $\triangle$ BOE − Area of quad AEOF − Area of sq OFCD

or $\triangle$ABC = 2$\triangle$BOE − 2 $\triangle$EOA − sq OFCD

$$\frac{ab}{2} = 2.\ r\,\frac{(b + c - r)}{2} - 2.\ r\,\frac{(b - r)}{2} - r^2$$

$$\frac{ab}{2} = r(b + c - r) - r(b - r) - r^2$$

$$= rb + rc - r^2 - rb + r^2 - r^2$$

$$= rc - r^2$$

$$= r(c - r)$$

Substituting the value of r from (1) we get,

$$\frac{ab}{2} = \frac{(b + c - a)}{2}\left(c - \frac{b + c - a}{2}\right)$$

$$= \left(\frac{b + c - a}{2}\right)\left(\frac{a - b + c}{2}\right) = \left(\frac{c}{2} + \frac{b - a}{2}\right)$$

$$\left(\frac{c}{2} - \frac{a - b}{2}\right)\frac{4ab}{2} = c^2 - (b - a)^2$$

$$2ab = a^2 - (b^2 + a^2) + 2ba$$

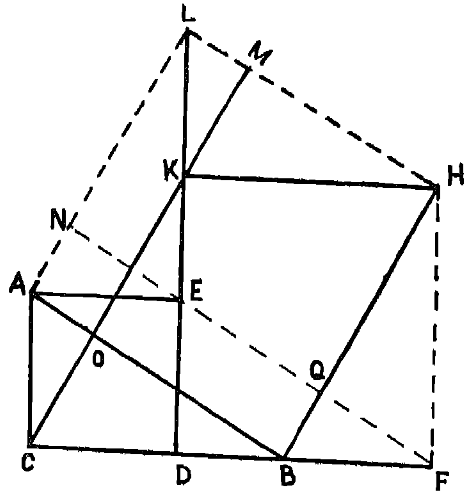
$$= c^2 - b^2 - a^2 + 2ab$$

Hence $a^2 + b^2 = c^2$

Sixth Proof

This method utilises areas of parallelograms instead of areas of triangles.

Take $\triangle$ABC right angled at C. Complete the squares ACDE and ABHL on AC and AB respectively.



Now construct CM $\parallel$ AL through C and FEN $\parallel$ BA through E.

Complete the figure as shown.

Now MOAL and KCAL are parallelograms and $\parallel^{gm}$ MOAL = $\parallel^{gm}$ KCAL (on the same base AL and between the same $\parallel^{s}$AL and CM)

= AC $\times$ length of the perpendicular between parallel lines AC and LK

= AC $\times$ AE

$= b^2 \quad \ldots.(i)$

Similarly HMOB and KHBC are parallelograms and are equal in area.

i.e. $\parallel^{gm}$ HMOB = $\parallel^{gm}$ KHBC

= KH $\times$ length of the perpendicular between KH and BC

= BC $\times$ HF

($\triangle$s ACB and BFH are congruent and FH = CB = a)

$= a^2 \quad \ldots\ldots.(ii)$

Now from (i) and (ii) we have

$\parallel^{gm}$ MOAL + $\parallel^{gm}$ HMOB $= b^2 + a^2$

$\therefore$ sq ABHL $= b^2 + a^2$

$c^2 = b^2 + a^2$

Yet another way of looking at the proof is

$\parallel^{gm}$ ANQB = $\parallel^{gm}$ AEFB = sq. AEDC $= b^2 \quad \ldots..(iii)$

$\parallel^{gm}$ LNQH = $\parallel^{gm}$ LHFE = sq. HFDK $= a^2 \quad \ldots\ldots(iv)$

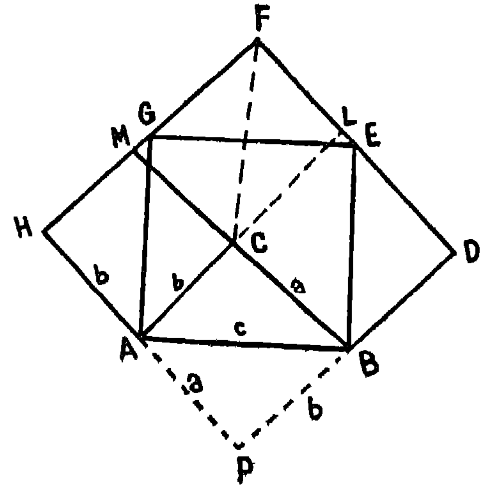
$\parallel^{gm}$ ANQB + $\parallel^{gm}$ LNQH = sq. ALHB $= c^2$
$= b^2 + a^2$ from (iii) and (iv).

The above proof is due to Professor Yanney.

Finally we give a proof which is due to Coloum.

Seventh Proof

ABC is a right angled triangle right angled at C. Produce BC, AC such that we complete the squares BCLD and AHMC respectively of area a^2 and b^2 Complete the square ABEG whose area is obvioulsy c^2. Now complete the figure as shown.



Area of sq. FP $= (a + b)^2$

But sq. FP = sq BG + $\triangle$FEG + $\triangle$ EDB + $\triangle$APB + $\triangle$AHG

$(a + b)^2 = c^2 + \frac{1}{2}ab + \frac{1}{2}ab + \frac{1}{2}ab + \frac{1}{2}ab$

$a^2 + b^2 + 2ab = c^2 + 2ab$ Hence $a^2 + b^2 = c^2$

We conclude this article by reference to a very recently published article, which is yet another proof of this theorem, in December 1970 issue of *Mathematics Education* by Shri S. Venkataramaiah. There can be many more variants and it is necessary for mathematics teachers to share these proofs with each other in order to ensure maximum professional growth for themselves and to enable them to teach students in a better and enlightened way.

Environmental Biology

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An unprecedented threat to human survival has arisen from increased population. The soaring growth of our population has created multitude of problems. that of hunger, malnutrition, poverty, and economic and political instability. In our own country the population problem is attaining serious dimensions. We are already more than 554 millions and, at the current rate of growth, the population is going to double in only 27 years. Population explosion is not only peculiar to our country, but is a characteristic feature of all the developing nations of the world which do not have enough resources even to meet the present situation. Apart from the problem of feeding and clothing the increasing number of people individual freedom is rapidly eroding under the pressure of swelling population. There is a growing realization that unchecked rate of multiplication lies at the root of most vexing problems with which mankind is faced today.

Man is degrading his own environment at a terrifying rate in addition to an ever-increasing demand of natural resources. The cumulative effect of our advancing technology, massive industrialization, and urban concentration have all combined not only to create danger to the quality of human life but even to pose threat to life itself. Many species of wildlife, which were thriving a few decades ago, are now extinct and the list of endangered species is growing steadily. Our life-supporting systems such as air, soil and water are not only going to be limiting but being poisoned by pesticides and many other harmful chemicals. DDT is one of the most used organochlorine pesticides which has been shown to be harmful to all forms of life due to its long-lasting residual toxicity. Ecology has emerged as a science of crucial importance because it deals with the interaction between living things and their environment.

The study of ecology is based on recognition of the existence of organic and environmental units known as ecosystems. An ecosystem is a relatively independent unit of nature consisting of groups of organisms broadly classified into producers, consumers, and decomposers interacting within the natural ecosystems exhibiting structural and functional stability which is maintained by cycling of nutrients and down-hill transfers of energy. All ecosystems possess feedback mechanisms to recover from environmental modifications. There is, however, limit to the ability of nature to recover from environmental stress whose intensity and frequency are greatly amplified by our technology. Hence, we cannot afford to assault our environment indiscriminately. In the absence of this realization we are now faced with the problem of environmental deterioration resulting from pollution of air, land and water. Environmental biology broadens our outlook and helps us to see the effects of our activities in wider perspective.

In developing countries the problem of environmental conservation is more acute

and demands immediate attention. In our zeal for progress and industrialization we forget to consider the consequences of environmental manipulation. For example, life span of many dams is greatly reduced by increased rates of silting caused by excessive felling and mismanagement of their catchment areas Prolonged disregard of environment can undo all our efforts to progress We could hardly gather resources in qualities needed to repair the environmental damage promoted by wide-spread public apathy. The preventive conservation is more effective and less expensive than restorative conservation We must, therefore, look into all problems before undertaking any large-scale technological enterprise. Consideration of environmental conservation may generate heavy emotional involvement as it tends to balance between our needs and quality of environment

To prevent further deterioration and depletion of raw materials we should learn to process and recycle our waste products. A sound knowledge of the structure and function of nature is necessary for planning and management of resources. This implies an intensification of basic research in ecology and environmental biology to enable the application of negative feedback mechanisms in the exploitation of our finite resources. Our universities should encourage and provide sufficient support for the growth of these interdisciplinary fields

An important function of educational institutions is to increase public awareness to support policies pertaining to the ecological management of the environment. In this effort universities and colleges have a major role and responsibility. We should, therefore, introduce courses on ecology and environmental biology to motivate younger generations The new courses in environmental biology must emphasize functional interrelationships, with the help of local examples, among the various organisms including man. It should also provide frequent opportunities for field work, firstly, to show species diversity in nature and, secondly, to bring home the idea of conservation ecology.

A brief outline of the course-content is given below. This can serve as a basis to evolve a suitable curriculum

Comprehension of man as member of the biome, his life support system, evolutionary and cultural history.

Evolution of the biotic and abiotic environment of man.

Man in the ecosystem, exchange of materials between the organisms and environment, flow of energy and carrying capacity of the environment. Analysis and modelling of the ecosystem.

Man in health and disease

Population of the environment, technology and maintenance of environment

Population dynamics, human population and resources.

Quality of human life.

How many persons can live on the planet.

Human ecology, sociology, politics, education and other cultural and social aspects in the age of science and technology, and in the context of balance of nature or maintenance of healthy environment

There is no doubt that we cannot progress and maintain quality of environment under the burden of mass ecological illiteracy. Resuscitation of our environment is possible only through action based on collective and collaborative understanding between public and policy makers.

Pollution: A Biological Problem

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THE history of life on earth has been the history of environment moulding the various forms of life according to the changing conditions, and the history of struggle for existence between the various life forms, or between the variants of a particular life form, to give rise to a natural biological community which is in equilibrium with the surroundings. More recently, man has been indiscriminately polluting the atmosphere and ruthlessly modifying his surroundings in such a way as to make his own existence uncomfortable and difficult. He has been contaminating his habitat with the products of science and technology, and wastes and overflows of affluence, urbanisation and industrialisation. These contain harmful radioactive chemicals and innumerable deadly and poisonous substances. Most of such discharges are irrecoverable, and go on accumulating and spreading all over the globe The spreading and increasing pollution can be fought against by enforcing stringent laws by a world government, or by educating the masses so that groups of individuals and societies are aware of its dangers and take care to prevent it For the latter, there is a need to acquaint the common man with the basic principles of biology—there is a need to propagate the idea that man is but only a part of the huge biological community, and any effort to disturb the balance between the living and the non-living world will result into a catastrophe

Ever since life originated on this planet, external forces have been acting upon it. Thus, evolution has taken place due to an interaction between the living organisms and their environment, and there is a two-way relationship The organisms modify their environment and the environment, in its turn, modifies the organisms This leads to a succession of various types of organisms in a dynamic environment A particular organism, or species, invades or evolves in a certain environment, adjusts itself, changes the surroundings, and finally makes the environment unsuitable for itself, thus paving the way for its own extermination and fresh colonisation by other species.

It is well established that variations that are of advantage in relation to other organisms, and the prevailing conditions of life, succeed in the struggle for existence. Under the pressure of natural selection, only the fittest are able to survive. We also know that variations are caused by environmental factors Once the variations are caused and selected by nature, they are perpetuated and preserved until further variations are obligatory To give an example, in England, surveys carried out around 1850 indicated that most of the moths in different non-industrialised areas were light in colour, whereas a very few, less than 1 %, were dark. Later, with increasing industrialisation the percentage of dark moths increased so much so that in areas which had smoky buildings and countryside, about 90 % moths were

dark. Obviously, the moths that matched their environment best were the fittest in the struggle for existence.

Such examples have been piling up ever since Darwin put forward the concept of "Origin of Species", and ecologists are tempted to talk about a climax community or an equilibrium between the organisms and their environment. This is so perhaps, because, to a large extent the variety, form and function of the organisms have been moulded by the environment. Once the atmosphere has manipulated the biosphere according to its whims and fancies, if there is no further change, such a situation will give rise to a climax community in which the living beings and their surroundings will be in equilibrium with each other. A static situation will arise if the organisms are unable to modify their environment. But we know that living organisms have the capacity to change their surroundings.

If we consider the history of life on earth, the effects of environment are very conspicuous. But, the reverse in which life moulds its surroundings has not been very spectacular to be perceived. Only during the 20th century one organism—man—has gathered enough resources and momentum to modify the environment. Now the question is whether man, like all other species, is going to alter his surroundings so as to make it unsuitable for himself or is there going to be a compromise between man and nature? Do we agree with E B. White who says: "I am pessimistic about the human race because it is too ingenious for its own good. Our approach to nature is to beat it into submission. We would stand a better chance of survival if we accommodated ourselves to this planet and viewed it appreciatively instead of sceptically and dictatorially"? Albert Scheweitzer is not optimistic either when he remarks: "Man has lost the capacity to foresee and forestall. He will end by destroying the earth".

During recent years, much concern has been expressed about the pollution of air, earth, rivers, sea, etc, with potentially dangerous and fatal materials. This contamination is more and more in an affluent society, and has reached alarming limits in the more-advanced countries. The developing countries, where pollution is not yet a serious problem, should be cautious because a major part of pollution is irrecoverable. For the benefit of posterity, we should try to prevent the irremediable damage

It was not until 1954 that every thinking individual became aware of the tremendous power that resides in a fissionable atom. Within seconds the great cities of Hiroshima and Nagasaki were reduced to ashes The first atom bomb had exploded over Japan, and the immediate damage was due to the high temperatures and shock waves that accompanied the explosion. At that time, practically no attention was given to the hazards from the radioactive elements simultaneously produced.

Man has lived in a radioactive environment ever since he appeared on this plane This background natural radiation is of both terrestrial and cosmic origin Carbon^{14} and tritium produced by cosmic ray interactions with the earth's atmosphere and potassium^{40} from the soil are radioactive isotopes of essential elements in the biosphere Other radioactive isotopes, e.g., Thorium^{232}, Uranium^{288} and their decay products are widely distributed in the environment from time immemorial. Man's existence is ample proof of his ability to tolerate low levels of radioactive exposure—a tolerance that has developed in course of time—time in terms of millenia Whether this tolerance is real, or only apparent, is debatable. The net result of a fallout is a

small increase in the background radiation to which life is exposed, and raises the most difficult problem of all—that of trying to ascertain the significance of this small but noticeable increase to general health and well-being of the world population in particular, and the living world in general.

Since the time of Muller (1928) it is well known that radiations cause heritable changes in the germplasm of organisms. He also showed that doubling the dose resulted in approximately twice the number of mutations. It is now pretty well established that with increasing radiation the percentage of mutation increases. H. Bentley Glass and Rebecca Ritterhoff (1961) have indicated that even low doses of radiations (equivalent to or even less than the background radiation) are mutagenic. Thus, it is evident that there is no safe dose from the genetic stand-point. The background radiation produces some genetic damage, and an increase over the background increases the frequency of this damage. This is the main reason why geneticists are so concerned that the human species should receive no more radiation than is absolutely necessary, specially during the reproductive years. It is also well-established that sometimes radiations kill the cells or disturb their normal and regular growth and division, or cause them to become malignant in course of time.

Besides the direct effects, radiations have some indirect effects too. It has been proved beyond doubt that irradiation results into the generation of peroxides in the substrates which can then be lethal mutagenic to a variety of organisms growing on them (Chopra, 1969). This leads one to think about the possible biological hazards, specially those resulting from the use of food materials preserved by exposure to ionising radiations.

It is heartening to note that the people are, to some extent, aware of the hazards of radioactive pollution. But they do not seem to be much concerned with other types of pollution. Take the case of pesticides. During the last three decades a number of them have been synthesised and widely distributed all over the globe, so much so that many of them are quantitatively recoverable from both animate and inanimate objects. In many developed countries people are aware of the problems of pollution, and are trying to fight it on all fronts. U.S.A. has banned the use of many herbicides, insecticides, fungicides and similar poisonous and dangerous chemicals, and in many cases the European countries are following suit (Mellanby, 1967; Graham, 1970).

There are greater dangers of increased pollution in a more affluent society. Talking about increasing hazards of pollution in European countries, Gene H. Hogberg says: "It is Europe's own burgeoning prosperity that is threatening to swamp the continent under a swelling tide of pollution". We, in a developing country like India, are passing through a critical phase of rapid industrialisation and urbanisation. In some ways we are in a better position to guard against the errors that the more affluent countries have committed. We are in a position to prevent excessive pollution, if we are careful enough, and if we take lessons from the curative and preventive measures adopted by other countries.

This does not mean that our land, atmosphere and body are not at all polluted. In some cases we are already too late. Living in a society sustained by agricultural economy, we have used the herbicides, fungicides and insecticides mercilessly and ruthlessly during the last few years, specially because under the threat of population ex-

plosion, starvation, famine, drought, etc., we have been pressed to protect the standing crops, at all costs As a result many chlorinated hydrocarbons have been sprayed over millions and millions of acres in India. Such compounds are vicious pollutants and are not easily broken down to simpler compounds. They go in the soil, are taken up by the plants, and ultimately reach the animals. Being insoluble in water, but highly soluble in lipids, their concentration increases in living organisms and decreases in non-biological objects. It is, therefore, not surprising that even the Penguins of the Arctics have traces of chlorinated hydrocarbons in their body fats. Man is not an exception An average Westerner carries about 5-12 parts per million DDT in his body. People in the Western countries are better off in this respect because they became aware of the involved hazards much earlier and banned the use and manufacture of DDT and other similar chemicals in their countries. But, surprisingly enough, we in India are carrying about 25 parts per million of DDT in our body, even then we are not bothered about its indiscriminate use. Collectively, more than 600 tonnes of DDT is being carried around in the fatty tissues of Indians and it is on the increase. Recently, Hindustan Insecticides Ltd (a public sector organisation) issued a pamphlet entitled "Spare the Saviour" and without much thought, rushed to the defence of DDT, thereby arousing a lot of controversy in the press and public. Perhaps, they are not fully aware of the assertions of Peter Raven of Stanford who says · "There is rock-solid evidence on what these chemicals do to other animals. It would be a bad mistake to think that man is unique". Thus, before using the potent and more effective pesticides, we should think a little more about the ultimate outcome and the possible alternatives like biological control measures. The latter would need a crash programme in education and research to natural methods And, for this mass consciousness and mutual co-operation are the two pre-requisites

Some of the chemicals that we use as herbicides, fungicides and insecticides are more dangerous than radiations Radiations are harmful because they are mutagenic and lethal Chemicals too are mutagenic and lethal This important discovery was made by Charlotte Auerbach and William Robson in the early 1940's at the University of Edinburgh, but seems to be little publicised Chemicals are effective as herbicides, fungicides and insecticides because they are lethal and mutagenic. While using them we forget that they affect all the living organisms, although to varying extents We also forget that we are one of the many varieties of living being on this planet

There are many other pollutants besides the pesticides They are the products of industrialisation and urbanisation and fell upon the natural resources which support life on earth. If we want a high material standard of living, without paying a big price for it, we should guard against the foul air and fetid water. Rapid industrialisation, mushrooming population, and fantastic increases in automobile ownership are the main causes of befouled atmosphere. So much so that cities like New York and Tokyo have a monthly soot fall of about 17 and 34 tonnes per square kilometre respectively. Sometimes there is so much air contamination in these cities that one cannot stand on the street for a few hours at a stretch without a gas mask The traffic policemen regularly return to their headquarters for a fresh supply of oxygen.

Oxygen is sold on the street kiosks too. It has been estimated that due to excessive combustion the oxygen reserve of the environment is gradually being depleted and the concentration of carbon dioxide, carbon monoxide, sulphur dioxide, nitrogen oxide and other harmful gases is increasing year after year. Oxygen balance is maintained largely by the marine plants and micro-organisms. But due to indiscriminate and excessive pollution of the sea water, the marine flora and fauna too is dwindling.

During 60 years between 1880 and 1940, earth's mean annual temperature rose by 0.40° C. Part of this increase is attributed to the increased carbon dioxide concentration of the atmosphere It is well established that carbon dioxide retains a lot of solar heat that is reflected by the earth. On the other hand, dust particles and aerosols are able to absorb sun's heat directly and help in cooling the atmosphere Even a little shift from the mean temperature of earth's atmosphere results in tremendous changes—such as movements of ice-sheets, wide changes in the amount of rainfall, etc It has been calculated that a rise of only 3.6°C in earth's mean temperature will result into molten poles and a consequent 100 metre rise in the sea level. You can well imagine the shapes of the continents and things that will follow. Besides indirect effects which result into a change in earth's temperature, there is direct thermal pollution. By burning enormous amounts of fuel, man is heating the atmosphere

We in India are in a difficult situation. As compared to the United States of America, we have nine times as much population density and were passing through a phase of rapid industrial expansion. In the race to catch up with or excel the Western countries, we forget that we are making our atmosphere unsuitable even for mere survival. The capacity of the dust particle cover is described in terms of the turbidity of the atmosphere. Surveys of the atmosphere conducted by the Meteorology Department in cities like Calcutta, Bombay and Delhi have shown that the turbidity has increased by 50-100% in recent years. In Delhi tonnes of dust per square kilometer is deposited from the air every month To monitor the effects of air pollution and urbanisation on weather, the Meteorology Department has undertaken urban climatological studies. It has set up some observatories in the schools of the metropolis for collecting data on the effect of pollution and urbanisation on the weather and climate of the capital We hope they will come out with critical observations and effective recommendations before it is too late

Cement and concrete constructions, which are synonymous with the growth of civilisation or urbanisation and industrialisation, store the solar heat during daytime and liberate it at night. Large cities, therefore, act as 'heat islands' and cycle and recycle the foul air within a limited area, thereby causing the build-up of pollutants to hazardous levels No one seems to be concerned with this. People are rapidly migrating from the villages to the cities to dig their own graves! City outskirts are often subjected to open dumping and uncontrolled tipping of solid, liquid and sludgy wastes which contaminate and disfigure the landscape, and pollute the air with unwanted odour. The noise and discharge of cars and lorries and overhead sonic booms are not less nasty.

Household sewage and industrial wastes transform the clean and clear rivers and tanks into putrid reservoirs. In our

country raw sewage is dumped into the rivers. Most of our cities lack sewage treatment plants. This has resulted, on many occasions, in septic conditions in some of our streams. Viral pollution of water, due to leaking sewers laid over water mains and the lack of adequate public sanitary facilities, has been responsible for the outbreak of diseases like jaundice, typhoid, etc. The people of Delhi have not forgotten the recent pollution of Yamuna near Okhla which resulted in the outbreak of jaundice in the southern parts of the capital. A survey carried out by the All-India Institute of Hygiene and Public Health, Calcutta, has shown that industrial wastes have caused serious public health hazards in U P., Bihar and Bengal Although drinking water for most Indian cities comes from rivers and so does 40% of the fish catch, we have converted all our rivers into 'open sewers'.

Rivers are the carriers and oceans are the final repositories of world's wastes. All pollution ends up in the seas. Man considers the vast expanse of the sea as a large dumping ground Only recently the United States of America has thrown as many as 1440 lethal nerve gas rockets near its Florida beach Disposal of radioactive nuclides, nuclear device testings and space shots have significantly increased the amount of radioactivity of the sea water. Pollutions due to the wastes and discharges and accidents of tankers and fishing vessels into the vast expanses of the oceans are not less important. The memory of the Torrey Canyon disaster off the English shore has not faded as yet. The floating oil killed innumerable sea-birds and the use of detergents proved highly toxic for the marine flora and fauna. Besides oil and chemicals, modern methods of fishing and widespread uses of kelps and other marine organisms is upsetting the ecological balance in the oceans The rising mercury and lead concentration in the marine fish of U.S.A is causing alarm because it gets converted into methyl-mercury and causes brain-damage, blindness or even death in human beings. Even one part per billion of organo-mercurial compounds have been found to inhibit growth and photosynthesis in marine as well as fresh water planktons. Many things are themselves not inhibitory to the members of the biosphere but in combination with other substances they may prove to be fatal. Sometimes prolonged exposures to non-inhibitory concentrations may be harmful.

Thus, whether it is an uneasing quest for better living or pursuit of affluence, man is playing havoc with his surroundings He is largely ignorant of and partly indifferent to the fact that pollutants interfere with the breeding behaviour, growth rate and even survival of an individual or its progeny. All these have a cumulative effect on the survival of a species and ultimately on the balance of nature.

The situation is made worse by the fact that pollution knows no provincial, national or international boundaries All of us on this planet breathe in the same atmosphere, and wastes discharged into the rivers of one country travel through various nations and provinces to the ocean and is then distributed all over the globe. Even the underground water is a good carrier as well as a reservoir of pollutants. Moreover, with the shrinking distances, the vectors of pollution become more and more active.

Problems of pollution, therefore, can be tackled on a national basis as well as continental front. Jaag (1969) has made out a good case for international and interdisciplinary co-operation in the field of waste-disposal. UNESCO, NATO, WHO and

other similar organisations are actively investigating these problems. As usual, they come out with marvellous recommendations but are helpless in the absence of any power to enforce them In some quarters people feel that under these circumstances we need a world government—a government that stands well above the conflicting selfish interests and pursuits of men and nations, a government that can effectively enforce the laws, and a government that can teach us to live with pleasure and in plenty It is the most difficult but fortunately not the only way out of the pollution problem. Public awakening and cultivation of the sense of individual responsibility are difficult to achieve but are sure to work wonders. If each one of us becomes conscious of the fact that if we take care of ourselves the world will take care of itself, we and our descendents will be able to live a much merrier life For this, we do not need to work from the top downwards, i e., from the world government, through continents, nations, provinces, districts, localities and families to individuals, but we need to strike at the root cause. We need to work from below upwards. The call of the hour is to acquaint the common man with the basic biological principles. The need of the moment is to bring about a thorough educational and social revolution

Who will take the lead? Sinha and Johri (1970) have emphasised that it is primarily the duty of the biologists. They will have to come out of their laboratories and will have to preach the biological solutions to biological problems. This does not imply that biologists can manage single-handed. They will need the co-operation of their fellow scientists and, above all, of the government.

There has been a sudden realisation of the potentialities of life sciences in the West which has led to remarkable shift of general interest to biological sciences. Every thinking individual is realising that man is a part, not only of a human but of a natural and meaningful biological community. Unless we are able to infuse this idea into the common mind, our educational and communitarian reforms are not likely to succeed, and our biological problems will be aggravated instead of being solved.

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Royal Society Delegation in India

ANTHONY TUCKER

Five distinguished scientists from the Royal Society, London, are at present visiting India. Led by Prof Alan Hodgkin, President of the Society, Sir Harold Himsworth, specialist in tropical medicine; distinguished chemist Sir Harold Thompson; and Sir David Martin, Executive Secretary of the Society.

A FIVE-MEMBER delegation from the Royal Society in London is visiting India at the invitation of the Indian National Science Academy.

Some years ago, I was at Trombay with the late Homi J. Bhabha and I remember being curiously disturbed by the disparity of building techniques and technological purpose. Indian women labourers were climbing pole ladders with handmade bricks to construct the filter stack of an experimental nuclear reactor. Would it not have been appropriate, I remarked, to develop modern techniques before developing reactors?

The reply was salutary. I was told: "India has enormous problems. She will be labour intensive for two generations or more, yet she must achieve full competence in the most important areas of advanced technology. What matters is the quality of science and the quality of engineering. The building techniques will look after themselves on the basis of social necessity."

Special Interests

The quality of science and the means of achieving it are among the special interests of the leader of the visiting group—Prof. Alan Hodgkin, President of the Royal Society. He is not only scientifically distinguished for his work on the transmission of impulses in the nervous system and a Nobel Prize-winner for medicine in 1963, but he is deeply experienced both in the structure and practice of post-graduate training and with development of research laboratories of the highest quality. He became President of the Marine Biological Association in 1966

Prof. Hodgkin is a former Assistant Director of Research at the University of Cambridge and now Professor of Biophysics. He already has extensive academic ties with America and with other countries. It is as essential to the fulfilment of his role as President of the Royal Society as it is valuable to the international fabrics of science.

Lord Blackett, a past President of the Royal Society and another distinguished delegate to India, is probably more aware of the special problems of India—and indeed of other rapidly developing nations—than any other leading figure in Western science.

His personal involvement with Indian scientific affairs stretches back almost 40 years and has been recognised by an honorary Doctorate from Delhi University (1947) and an honorary Fellowship of the Indian

Academy of Sciences (now the Indian National Science Academy) in 1949. The fact that Lord Blackett would in any case have been in India on a Royal Society. Leverhulme visiting Professorship is an indication both of his continuing involvement with Indian affairs and of the academic structures which already exist to bridge the geographic gap between the science of India and the science of Britain.

Lord Blackett is, in fact, the fifteenth senior British scientist to visit India in that special capacity since the establishment of Leverhulme Professorship in 1962, but his importance on this occasion is probably less that of the scientist than of the very experienced Government adviser. Lord Blackett's voice is one which Governments throughout the world have learnt to respect.

The fabric of international science weaving informal relationships with Government is probably one of the most important facets of 20th-century culture. Although it operates for most of the time behind the scenes, it can synthesise, moderate and inspire the development of policies without ever raising a single news headline. And it rests not on the inductive logic inherent to Western science, but on the personal experience of those involved.

Indivisible Entity

Taken in this light, all the members of the Royal Society delegation have much to offer. Sir Harold Himsworth, for example, formerly Secretary and Deputy Chairman of Britain's Medical Research Council and honoured in several European countries as well as the United States and in Africa, has a lifetime of experience in the organisation and structure of research, and in the special problems of medicine in the tropics.

There is perhaps a tendency to think of medical research as something distinct from medical practice, and to see tropical medicine as a separate and special branch of both Sir Harold does not speak of "tropical medicine" as if it were a special subject, but rather of "medicine in the tropics". He feels strongly that medical science is one indivisible entity in which no aspect can be segregated or neglected without detracting from the whole

Because of its academic roots, total integration of the whole spectrum of medicine from fundamental research to clinical application, and because of its smoothly operating research unit and grant structure, Britain's Medical Research Council has become the envy of the world. Sir Harold's experience could be invaluable to India, particularly at the present when the development of national medical structures and structures and centres of scientific excellence is advancing rapidly.

Similar considerations apply to Sir Harold Thompson, one of Britain's most distinguished chemists and spectroseopists, who has visited India many times and has many personal ties with Indian science. Again, his experience is not only that of science, but that of science and Government.

Research Collaboration

Professor of Chemistry at the University of Oxford and associated over many years with Government advisory bodies and with the Chemistry Research Board of the old Department of Scientific and Industrial Research, Sir Harold Thompson has been one of the most active participants in the development of the International Scientific Unions. These international bodies, separately representing the whole range of scientific disciplines, underlie a great deal of present-day international collaboration

in research and co-ordination of the many national research programmes It could well be that Sir Harold's experience in the development of resources both in university and industrial research will prove especially interesting in discussions in New Delhi. The structure of post-graduate research and its complex relationships with national and industrial needs are probably as well understood by Sir Harold as by any scientist in the world.

As India is now developing her own National Science Academy, particular value can be attached to the role of the fifth member of the group. Sir David Martin has for many years been the Royal Society's Executive Secretary, and his administrative experience will be a notable asset.

Indeed, Sir David's expertise, together with that of the leader, Prof. Alan Hodgkin, and Lord Blackett, has brought a particularly knowledgeable team to New Delhi at an important time From every practical aspect, they form one of the strongest and most potentially valuable teams ever launched by the Royal Society.

By Courtesy . British Information Services

How Royal Society Encourages Young Scientists

J. G. Crowther

Britain's Royal Society is the oldest and most famous scientific society. Though it is a private body, it performs functions similar to those of the national academies of science which in many countries are State institutions These eminent and often ancient organisations tend to become honorific bodies, bestowing national recognition of scientists in their later years, after they have done their best work.

It is very proper that a scientist who through his discoveries has made great contributions should receive appropiate honours, but it is desirable that these should come to him at a sufficiently early age to be an encouragement to further efforts. In its long history the Royal Society has given much encouragement to the outstanding younger scientists, and still does today, by electing them to its Fellowship as soon as their discoveries are seen to be of an important and solid character

The Royal Society, like most societies, was founded by young and enterprising men of talent. The leading figure in its foundation in 1660 was John Wilkins, brother-in-law of Oliver Cromwell, and then aged 46. Other foundation members were Robert Boyle, then 33, and Christopher Wren, 28, who graduated in medicine and was an eminent scientist before he became an architect.

Isaac Newton was elected in 1671 at 29 His incomparable work, *The Mathematical Principle of Natural Philosophy* was published in Latin by the Royal Society, at the personal expense of its assistant secretary, Edmund Halley, the dscoverer of the comet named after him, who was then 37.

President for 42 Years

The dominant figure in the Royal Society during the later 18th century was Joseph Banks, who was elected in 1766 aged 22 and became president 12 years later when he was 34 He continued as president for 42 years.

At the age of 25, Banks was a naturalist on Captain Cook's first voyage round the world, in 1768-69 During their visits to Australia and New Zealand, Banks say the possibilities of those countries, and it was mainly due to him that Britain developed them as agricultural colonies. He introduced the cultivation of the tea plant from China into Malaya as it was then and he inspired the famous voyage of Captain Bligh of the *Bounty*, the aim of which was to introduce bread-fruit trees from Tahiti for cultivation in the West Indies

Banks was an outstanding representative of the progressive agricultural aristocracy that ruled Britain in the 18th century. They were superseded by the leaders of the Industrial Revolution which took place in Britain in the latter part of that century Banks was succeeded as president of the Royal

Society by Humphry Davy, who consciously set out to advance the science of industrial processes. He was elected in 1803 at 25, and became president at 41.

Davy's most widely-known achievement was the investment of the miner's safety lamp, which enabled the output of coal to be increased and the British lead in industrial development to be extended. His laboratory assistant, Michael Faraday, was elected in 1824, at 32, seven years before he discovered electromagnetic induction, and 22 years before he conceived electromagnetic vibrations, or radio waves.

Charles Darwin was elected a fellow at 29, 20 years before he published his epochal *Origin of Species*

In Their Twenties

In spite of its record, the Royal Society began to feel in the 1850s that it was not giving sufficient recognition to the younger scientists. It was partially with the aims of remedying this that Thomas Henry Huxley was elected in 1851 at 26, and John Tyndall in the following year at 31. Kelvin and Maxwell were elected at 26 and 29, and J.J. Thomson and Rutherford at 27 and 31.

Throughout the Royal Society's history, most of the British scientists who became famous were elected before they were widely known, and the tradition continues today.

Among British Nobel Laureates is Professor P.A.M. Dirac, who 40 years ago conceived relativistic quantum mechanics, anti-matter and the anti-universe possible states of matter which are like a mirror of ordinary matter in terms of structure. He was elected at 27.

Lord Blackett, who was the first to photograph the disintegration of an atom, was elected at 35. The physiologist Lord Adrian was elected at 33 and Sir Peter Medawar, the leading authority on immunity on which surgical heart-transplants depend, at 34.

The brilliant band of British molecular biologists who have done so much to unravel the molecular structures on which biological heredity and other essential processes of life depend Dr. F.H.C Crick, Dr J C Kendrew, Dr M.F Perutz and Professor M.H.F Wilkins were elected between 1954 and 1960 at ages ranging from 39 to 43.

At the start of the 1970s, the Royal Society had 37 Fellows below the age of 45 and three younger than 40 (the latter being the mathematicians J.F. Adams and C.T.C. Wall, and the geo-physicist O.M. Phillips).

Maths Men Mature Early

Mathematicians and theorists are usually the earliest to mature. Adams and Wall are international authorities in the recondite field of topology, and abstruse development of geometry. Phillips has written particularly on the surface waves of the ocean, and the interaction between ocean waves and the atmosphere.

Among those under 45 are eminent mathematicians M.F Atiyah and K.F. Roth, elected respectively at 32 and 34, both of whom have received the highest International mathematical honour, the Fields Medal. Atiyah, who is Savilian Professor of Geometry at Oxford, is the son of a noted Arab publicist. His contributions to topology and several other major branches of mathematics have been profound. Roth has solved problems in the theory of numbers which mathematicians had attacked for centuries, such as the approximation to irrational by rational numbers.

Dr. N.A Mitchison was elected at 38. He is a grandson of J.S. Haldane, a nephew

of J.B.S. Haldane, and grand-nephew of Lord Haldane. He is director of the experimental biology division of the National Institute for Medical Research in London, where he investigates immunity in animals other than the human and pursues research which has a fundamental bearing on the problem of cancer.

A.R. Battersby, who has been appointed to a chair of organic chemistry in the famous Department of Chemistry at Cambridge directed by Lord Todd, was elected to the Society when he was 41. He has published much on the chemistry of natural products, especially on alkaloids important in medicine.

Science and a Poet

Desmond King-Hele was elected at 38. After the launching of the first artificial satellites he took the lead in the determination of the properties of the upper atmosphere, and the earth's gravitational field, from an exact analysis of their motions. He combines international eminence as a theoretical astronomer with notable contributions to literature. His book *Shelley: His Thought and Work* contains a unique study of the influence of scientific ideas on Shelley's poetry.

One could make than one list of the younger Fellows parallel to that which has been made here, but this will suffice to show that the Royal Society has generally encouraged gifted scientists by electing them at a comparatively early age, and that it continues in the tradition with which it started three centuries ago.

The Society also provides more than a score of senior research fellowships, mostly held by abler younger scientists who subsequently become candidates for fellowhsip. It awards annually about 200 bursaries of various kinds to British and foreign scientists. Finally it gives grants to nearly a score of schools to help research projects, so there is even a direct connection between the Society and research-minded schoolboys.

By Courtesy : British Information Services

Science in Science Clubs

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EVERY now and then concern is expressed by our scientists, teachers and politicians about the state of science education and scientific research in India, and their impact on the people. The blame is usually laid on bureaucracy crippling the creative scientists, on lack of funds and equipment, on the "brain drain" and on nepotism. K.M. Panikkar, the well-known historian and diplomat, in his book, *A Survey of Indian History*, questioned the cause of the sudden and unexplained failure of intellectual curiosity, which is evidenced by our arrested progress in scientific work after the sixth century. He suggested that Indians had gradually lost the questioning attitude and the eagerness to learn when they became steeped in a self-satisfied tradition. This point of view may be disputed but it contains some truth as far as science in India today is concerned

Most contemporary Indian adults as parents and as teachers at various educational levels, discourage questioning by the young. Often questioning children are called impertinent and the child who rarely questions but accepts all adult "wisdom" is held up to esteem By adulthood, the art of intelligent questioning is lost in many and acceptance becomes the normal way of life. Fortunately *all* normal children are great questioners but some can be easily put off while others persist in getting an answer from others or by their own efforts Future researchers in all branches of knowledge are usually found in this latter group. Children's questions cover all fields of human knowledge and endeavour

In school, children's questions are discouraged because classes are depressingly large, the syllabus has to be "finished" or the teacher is more inclined to ask questions than to answer them. A large proportion of children's questions relates to the world around. Those questions which relate to the world which can be experienced by the senses may be called scientific questions. Science clubs, which exist in many schools and colleges, offer the best opportunity for asking scientific questions and for arriving at answers by individual or group effort. Unfortunately in many science clubs, the "club" is stressed more than the "science". The usual activities of a science club are an inauguration and a valediction with one or two "talks" and/or an excursion and film show in between the first two.

Schools display individual or group student efforts at science fairs and exhibitions Many of these including some prize winning entries have little science in them. Models in papier mache, clay or plasticine of the human skeleton, the parts of a bean seed or the engine are really works of craftsmanship Portraits of eminent scientists by student artists, however startling the resemblance, are just works of art and not of science Neat set-ups of experiments described in the textbooks are not original

scientific activity but are good teaching aids A board with possible answers to a set of questions, in which the correct answer lights up when the right button is pressed (because of the planned electrical circuiting) is displayed with pride by atleast one school in all science fairs. This attracts a crowd and often wins prize but it cannot be called a scientific activity Assembling a radio receiving set also belongs to this category. If the various activities mentioned above are not scientific activities, what others can be considered as such?

All scientific activities are outcomes of the scientific attitudes One of the best descriptions of the scientific attitudes was given more than 300 years ago by Francis Bacon as "The desire to seek, the patience to doubt, Fondness to meditate, Slowness to assert, Readiness to reconsider, Carefulness to dispose and set in order, and hating every kind of imposture". Asking questions relating to the world around and seeking valid answers to them should be the chief activity of any science club, if the emphasis is to be on "science" and not on "club". Two things follow from this statement: (1) *All* students (even all students in a science group) cannot be expected to be really interested in scientific activities as many who do not have scientific aptitude get into science groups. The science club should be a select group of really interested staff and students. Film shows and interesting talks may be thrown open to all. (2) The products of genuine scientific activity may not in many cases be as attention catching in science fairs and exhibitions as a handsome papier mache skeleton or a tinkling self-assembled radio receiving set or a huge portrait of Newton. But written reports of the project with appropriate details, figures and samples of processes and products can be presented to the public with the investigator near at hand to give additional information if needed

What are the characteristics of activities worth undertaking in a science club? Briefly we may say such activities centre round questions beginning with What, How, Can, Will it. Such questions are often asked by children. To answer them, observation, experimentation and reading are needed Experimentation does not require well equipped laboratories though they help. A resourceful mind is of greater value than the most sophisticated equipment. The following are two examples of science projects: (1) *Can plants manufacture starch in artificial light*? (This question was asked in the class by a boy in standard V but his teacher replied, "We are talking of sunlight and not electric light.)

Take two potted plants of the same kind and age (bean or balsam) about six inches high Keep both in the dark for 24 hours but water them (Why?) Then expose one plant to direct sunlight for six hours and the other to the light of a 60 watt electric bulb from a distance of five feet in a light-tight room for the same six hours. Test leaves from each plant for the presence of starch.

(2) *Will ragi instead of expensive polished rice, as the chief item of diet, really make a difference in health*?

Take two healthy young pigeons of the same brood. Put one (A), in a small bag and weigh it in a spring balance. Using the same bag and balance weigh the second bird (B). Feed A on expensive polished rice and the other on ragi. Do not give them anything else besides water. Feed them adequately each day. Weigh the birds at weekly intervals. After three weeks is there any difference between the birds in (a) weight and (b) appearance?

The above two projects are suitable for

elementary school children. These children usually do not have science clubs but would benefit more from science activities than older pupils as they have not lost to a great extent their ability to ask questions. Older students can seek answers to questions like "Does burning anthracite give out more heat than an equal weight of burning lignite?" "How is the school environment being polluted? What can we as students do about it?" "What is nuclear energy? How do nuclear radiations kill", etc. The last is a reading project. Science is advancing so rapidly that none can aspire to keep track of its advances except in certain narrow fields. Our Indian students will remain handicapped in gathering scientific information by reading as we do not and will not in the near future have suitable and adequate reading material in the Indian languages and most of our students lack the ability to read profitably in English.

Many children ask interesting questions but they need training in asking intelligent questions. For sustained interest and hard work, the question must arise from the student and not be imposed on by the teacher. Children need training in devising adequate and relevant means of arriving at answers. A certain amount of trial and error is inevitable. Devising methods with available materials, gathering information by observation, experimentation, and reading, controlling variables, identifying and rectifying errors, inferring, imagining and testing are all time-consuming processes and call for perseverance, but the joy of arriving at what was sought and the training involved amply compensate the hard work.

Around the Research Laboratories in India

Sugarcane Breeding Institute Coimbatore

The Sugarcane Breeding Station (now Institute) came into being in 1912 and was charged with the function of breeding improved varieties for the sub-tropical areas of India, wherein lies the bulk of the sugarcane area.

At its inception, the Station was under the administrative control of the Director of Agriculture, Madras. In 1924, the Station was taken over by the Government of India under the administrative control of the Agricultural Adviser to the Government of India and as part of the Imperial Agricultural Research Institute, Pusa (now Indian Agricultural Research Institute at New Delhi). In 1950 the Station was taken over directly by the Government of India (Ministry of Food and Agriculture). Its status was raised to that of an institute and the designation of the Head of the Institute to Director from Government Sugarcane Expert. The Director till recently was Dr. J. Thulja Ram Rao with 37 research staff.

Aims and Organisation

The functions of the Institute are:

(1) To breed improved sugarcane varieties for all the cane tracts of the Indian Union;

(2) To conduct fundamental research on the botany and cytogenetics of sugarcane as also on certain physiological, chemical, mycological and entomological aspect of sugarcane; and

(3) To impart post-graduate training in sugarcane breeding and botany.

Sugarcane Research Institute, Coimbatore (Main Building)

The Institute is maintained by the Government of India (Ministry of Food and Agriculture, New Delhi) The Head of the Institute is the Director who is also in-charge of the breeding work. In addition to the breeding section, the Institute has six other sections dealing with different aspects of sugarcane research, *viz*, Cytogenetics, Botany, Physiology, Chemistry, Mycology and Entomology. There is a nucleus staff on the statistical and meteorological sides. The Institute has a Sub-station located at Karnal (Haryana) in sub-tropical India

Achievements

The Coimbatore Institute was founded to fulfil a definite need of the Indian Sugar Industry, *viz.*, to breed new varieties of sugarcane to replace the old idigenous varieties which were notoriously poor in yield, giving hardly 10 tons of cane per acre. This objective has been fully achieved. The birth of new era in Indian sugar industry is closely linked with the activities of the Institute, which has, during the past five decades, strived to evolve improved varieties, firstly for sub-tropical India and since 1926 for tropical India as well. The improved hybrid Co. varieties provided the much needed raw material for the industry and the best evidence of the achievements of the Institute is a stabilised sugar industry in India as witnessed today The grant of the fiscal protection in 1931 gave the needed fillip to the renaissance of the sugar industry From a country importing sugar to the tune of about Rs. 150,000,000 annually, India is now not only self-sufficient but also entering the world market.

The work of the Institute and the results achieved are widely known. On the botanical side, the work of Dr. Barber on the morphology and classification of the Indian canes has provided exhaustive knowledge on them, the improvement of which was the major objective of cane breeding in India. The deliberate utilisation of the wild *S. spontaneum* in breeding (for the first time in the sugarcane world) and which was later adopted in Java was responsible for the success of the Co. canes as it introduced the needed hardiness and frost resistance into the seedlings. Both the above important lines of studies have won for the Institute a recognition as one of the leading centres of research on sugarcane. The inter-generic hybridisation attempted (again for the first time) at this Institute is well known in the botanical world. The sugarcane × sorghum crosses and sugarcane × bamboo crosses which among others are Dr. Venkatraman's outstanding contributions to science, have been acclaimed as of considerable importance from the academic and scientific points of view The Institute can be said to be the pioneer in the study of the root system of sugarcane, a knowledge of which is so valuable to the sugarcane breeder and agronomist

The sugarcane variety is the pivot round which revolves the sugar industry and as in other sugarcane growing countries, in India also, the variety has been the centre around which agronomic improvements have been built. The Institute, by sustained research, has produced improved sugarcane varieties to suit the diverse soil and climatic conditions and the varying needs of the white sugar and gur industries. These have formed the backbone of the industry. The earliest Co. varieties, *viz.*, Co. 205, Co 210, Co 213, Co. 214, etc , replaced the indigenous canes while the later ones, *viz.*, Co. 312, Co. 313, Co. 331, Co 419, Co 421, Co. 453, Co. 740, Co. 997, etc., have in their turn replaced the earlier

series because of their better performance.

The improved varieties now occupy more than 90% of the sugarcane area in the country. With the increase in acreage under improved varieties, the yield per acre has also risen up. Though the all-India acre yield is only about 15 tons, the canes are capable of giving yields of 30 to 35 tons on an average in North India and easily about 40 to 45 tons in tropical India, given the essential agricultural facilities Actually much higher yields have been obtained by individual cultivators. The highest acre yield obtained in cane competitions in Northern Region is 80.12 tons and in the Southern Region 150.51 tons.

The Co. canes have proved successful not only in India but also in other countries such as South Africa, Louisiana and Australia In addition, varieties like Co. 419 and Co. 421 have been in cultivation in Cuba, British Guiana, Jamaica, etc Certain of these varieties have found a place in the list of ideal parents for evolving suitable seeding canes.

Research in Progress

Progress in breeding work consists in exploring systematically the genetic variability available in varieties and in the adoption of new and modern techniques for efficiency in breeding and selection work. This has been the objective of the Institute. The collection of 400 clones of the wild relative *Saccharum spontaneum* by personal visits throughout the country and the neighbouring countries in South East Asia, Middle East and Africa has placed in the hands of the breeder a wide tool for effecting variability. These clones are being used in the breeding work and the collection forms one of the best collections of wide species in any crop. The new tool of introducing variability through mutation is being pursued. Sugarcane varieties are being subjected to acute irradiation by Gamma rays. Varieties are being grown in the Gamma Garden at Indian Agricultural Research Institute, New Delhi for chronic irradiation. In addition, use of radioisotopes is proposed to be taken up for understanding and solving problems connected with the breeding technique.

On the cytogenetical side, studies on the *Saccharum* species and allied genera has thrown valuable light on the phylogenetic relationships between the species and the probable origin of the cultivated sugarcanes. Photoperiodic experiments for induction of flowering in sugarcane have been highly successful and it has been possible by suitable manipulation of light and dark treatments to induce flowering in non-flowering sugarcane varieties and synchronise the flowering period of early and late varieties. This success has placed with the breeder more material for hybridisation work.

In connection with studies on the resistance of sugarcane varieties to diseases, particularly red rot, techniques and method of assessment have been standardised.

Sugarcane Sub-Station, Karnal

The Coimbatore Institute has a Substation at Karnal (Haryana) which is a vital link with the main sub-tropical belt in India. Eighty per cent of the area under cane in the Indian Union being in the subtropical belt, this sub-station has been useful in the selection of parents for evolving canes resistant to frost and drought The basic information of planning the hybridisation work at Coimbatore has been forthcoming from the sub-station. The subtropical belt has benefitted from Karnal work in that certain of the seedlings selected,

like, Co. K. 26, Co. K. 30. and Co K. 32, have been in commercial cultivation.

The sub-station now serves as a regional station for raising seedlings from fluff and selection of suitable varieties for the North-West agro-climatic region comprising Punjab, Western U.P. and Rajasthan.

Sugarcane Regional Sub-Station, Cannanore

The Institute has been recognised as one of the two centres for the maintenance of a world collection of sugarcanes. This collection comprising over 2,000 clones is maintained at the Sub-station, Cannanore. The intention of maintaining the varieties at Cannanore is to ensure their freedom for diseases.

Post-Graduate Training

The Institute offers a short course of three or four months' duration for those actually engaged in sugarcane work in Government Departments, factory estates or private farms. A few suitable candidates are also permitted to do research work (honorary) under proper supervision and guidance and submit theses for higher degree (Ph. D.) to the Madras University Certain students from other countries also have availed of the one year course and short course of training.

Liaison and Information

The Institute maintains close relations with other research institutions in India and abroad particularly those connected with sugarcane by exchanging annual reports and reprints of scientific papers. Excellent exchange relationship is maintained with many sugarcane growing countries in the matter of plant material of varieties.

The Institute maintains close contact with the cane growers and the industry A large number of enquiries are received every year from cane growers and factories regarding sugarcane varieties and agriculture. There is a regular flow of visits from cane growers and factory staff to the Institute to gain first hand knowledge of suitable varieties. Members of the staff visit the State Sugarcane Research Stations, cane growers' fields and factories These visits and discussions have encouraged the agriculturists to bring their problems to the Institute and advice is freely given.

Classroom experiments

Learn Biology from Your Surroundings: Project Work

MOHAMMED AZAM

Investigator, Government Multipurpose High School, Karimnagar (A P.)

SCIENCE in today's classroom needs to face demands of parents, the society, and the changing system of education. It is to be replaced by an activity-oriented programme which provides sufficient scope for pupils to develop their individuality, initiative and habit of cooperation

Keeping in view these changed needs, the investigator along with other science teachers of the school resolved to vitalise the current method of teaching, so that the students could take active part, exhibit their creative interests and supplement their knowledge by way of activities, both inside and outside the classroom. This will help them in developing their power of judgment, as well as clear thinking and sound knowledge of the subject-matter. With these objectives keeping in view the investigator had discussed the matter with other members of the staff and decided to take up the project work.

Aims and Objectives

Our project aims at:

(1) Gathering new knowledge and developing its understanding among students from their surroundings.

(2) Developing the skills and attitudes in collecting various natural exhibits through spot surveys or practical work.

(3) Skill in collecting data through self-study for references.

(4) Atmosphere created to make the student relax and enjoy learning.

(5) Specific aims in mind to teach science in this modern world in the classroom or out of the classroom.

(6) Teaching with the help of natural aids or exhibits.

(7) To help the pupils to be aware of the impact of general science on their natural surroundings and on society.

(8) Skill of using sufficient science materials to enable the students to obtain an appreciation of variety of living and non-living things.

(9) To encourage group discussions and reference work.

(10) To bring the young and energetic and talented pupils to our country as the future of our country lies on their shoulders.

(11) To encourage them to participate in science talent search examinations and to the district-level, and state-level science fairs.

(12) Developing the spirit of co-operative work.

Delimitation. This project "Learn Biology from Your Surroundings" was limited to the study of General Science or Natural Science and it was restricted

to Class X Section D consisting of 40 boys A period of eight weeks was fixed for the completion of the project.

Procedure· Before starting the project work I, as an investigator, discussed the details of the project with four of my colleagues and with all the 40 boys. Then we all followed a detailed discussion regarding the respective assignments

In the course of our discussion it was discovered that though the students were reading in Class X they did not know the kinds of leaves, roots, stems and Chordates and non-Chordates and many things of natural science practically.

It was, therefore, decided that the students make their own efforts and should gather information about them taking field trips.

They were divided in four groups A. B. C. and D. Each group consisted of 10 boys. Each group elected a group leader and recorder. Each group had one student artist to help the group in making sketches and drawings.

Group Assignments

Group 'A' was assigned to collect all kinds of leaves, leaf modifications, xerophytic leaves, all kinds of roots, root modifications, storage roots and underground stem modifications.

Group 'B' was assigned to collect the various kinds of armless insects, belonging to phylum arthropoda and other non-chordates with the help of insect trape, etc.

Group 'C' was assigned to collect the various kinds of flowers, that is, regular flowers, irregular flowers, gamopetalae and polypetalae and the flowers like water lilly, etc.

Group 'D' was assigned to collect the specimens of phylum annelida and mullusca, for example, leech, earth worm, fresh water mussels, snail, round worm, etc.

For gathering first-hand information, study tours concerning the project work were arranged on a holiday with the permission of our Headmaster They include the following.

Visit to Elgandel Fort

There is an old ancient fort about 5 kilometres from our school. First the boys visited the fort with me and under my guidance they have seen all the locations of the fort.

Due to the winter season the fort was full of various kinds of plants and trees.

Group 'A' was allotted to collect leaves and roots. Hence the students of Group 'A' were busy in the collection of various kinds of leaves and roots with keen interest

Group 'B' was engaged in the collection of various kinds of insects like butterfly and millipeds and cendipeds, etc

Group 'C' students were collecting various kinds of flowers on the trees of the fort.

Group 'D' was assigned to collect annelids and molluses as the river Manir is passing nearby the fort. Hence the Group 'D' students were very busy in the collection of various types of annelids and mollucs on the river belt.

The investigators and four science teacher guided the group discussions. After the discussion, group leaders prepared the brief reports on what they have collected with some of their primary characters and how to identify them.

Considerable improvement was noticed by the investigator and the teachers in the method of individual reporting. The boys were very much interested to learn the new things from their surroundings.

Visit to Sugar Factory

About 4 km from the school there is sugar factory at Alugunoor, on the river Manir This sugar factory has been newly set up with the help of a co-operative bank The factory is running very smoothly. After the Elgandal Fort visit the visit to sugar factory was arranged to get the first-hand information of the preparation of sugar and molasses, etc.

About 40 boys participated and visited the sugar factory with the investigator and the other four science assistants were with us. The manager of the factory was known to the investigator and he had fully extended his co-operation to the investigator

Students were engaged in looking the processes of sugar preparation with keen interest. They were writing some of the important points which were explained by the manager. The students keenly observed how the sugarcane will be crushed and under how much temperature it will be boiled and why the sulphur, calcium and tinopal will be added to the sugar juice. They have learnt how to prepare jaggery at home by the simple method.

Talks

In order to clear the doubts the students were interviewed by the factory's Chemical Engineer, Mr. Das and explained the process of preparation of sugar, molasses and alcohol in a factory. Students were asked to note down the points which were given by him.

Self Study

Our school has got a good collection of science books with a trained and an experienced librarian The investigator has selected some of the science general books for the reference of the students which will be helpful for the project. Boys idividually referred the library books and noted some of the important points for their projects.

Talks Arranged

The District Education Officer, Smt. K.L. Hammond, B Sc, D.P Leeds, Edn, herself a science graduate was kind enough to give a talk on "Plants and Animals in Nature," which was very interesting and she explained the general characters of plants and animals Shri Dharmaiah, Head, Department of Biology of Government Science and Arts College, Karimnagar and Shri G. Rajesham, B.Sc, B.Ed. and Shri S.S Sirajuddin, B Sc, B.Ed., and the investigator Shri Mohd. Azam, B.Sc B Ed. also spoke on the occasion emphasizing on the living on earth in general.

Group Reporting

Boys maintained individual diaries and noted information therein. They prepared their own reports with the help of their diaries. They have checked their reports and read them thoroughly. And then group leaders prepared the group reports under the guidance of the investigator. The students sat for four sessions and consolidated the reports with the help of the investigator

Preparation of Charts and Models

Students prepared charts and models with clay of some of the plants and animals. These were displayed in the Biology Laboratory, which was very good, some boys prepared the charts of 'Conrivorous Plants' and some boys prepared the models of Amoeba, Hydra and some of the non-chordates. They were exhibited in the District Annual Science Fair and won the prizes and merit certificates The investigator as convenor of the District Science Fair was awarded the first prize for his contribution

of an interesting new exhibit. District Educational Officer, Superintendent of Police and the District Collector and the local eminent personalities attended the Science Fair and praised the work of our students.

Evaluation

The individual diaries and group reports which were submitted by the students and group leaders were examined and evaluated by the investigator and other eminent science teachers on a 4-point scale

Category secured	*Excellent*	*Good*	*Fair*	*Poor*
Students	8	20	8	4

The four groups were evaluated as under:

Group 'A'	Good
Group 'B'	Fair
Group 'C'	Fair
Group 'D'	Good

An essay competition was held on 22 January 1971 The topic choosen was "The value of Biology in day-to-day life". The investigator with the help of senior science teachers got it corrected. Three boys were given first, second and third prizes respectively, for their excellent performance. Twenty-five boys scored good and 12 boys scored fair and they were awarded merit certificates.

Three short-answer type questions were given under the following four categories.

1) Questions with multiple choice answers
2) Questions on the filling up for the blanks
3) Questions to match items
4) Questions to pick out true or false answers.

The answer papers were corrected by the investigator and the boys secured the following percentage of marks.

Percentage of marks	*Total number of boys*
Less than 45%	Nil
50%—60%	7
60%—70%	18
70%—80%	10
80%—90%	5
Above 90%	Nil

Conclusions

On the basis of the students' performances, i.e., the individual diaries, group reports, test results and personal observance with the students the investigator has come to the following conclusion:

1. As a result of the project the boys became very happy and became acquainted with many new things and gathered and learned information which they did not have before.
2. In the excursions, i.e., on the spot surveys and group work helped them in developing the habits of co-operative work and sense of high responsibility and respect to the teachers who were guiding them on the spot survey.
3. They could freely speak with their teachers in order to clear out their doubts in the project programme
4. Many of the students learned and developed the skill of drawing charts and preparing the exhibits with clay, etc. Skill of preparing exhibits has not been fully developed in all of them.
5. This project enabled the school and the investigator to discover the boys who were talented in drawing and exhibits preparation with artistic aptitude.

This kind of treatment of the topic general science or the curricular can be effectively implemented only if the teacher has

thorough knowledge of the subject, has powers of observation, and thoroughly plans effective and intelligent methods of elicitation.

These boys can become good artists if proper care and guidance and work-experience are provided to them from time to time.

Four trained teachers have worked with the investigator and they have showed their interest significantly The capacity of controlling the students in the classroom and out of the classroom proved satisfactorily.

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Field Studies in Biology

(The following activities were included in the Biology Programme of the Summer Institute conducted at the Delhi University, Zoology Department. Published by courtesy of the Department —**Editor**)

ZOOLOGICAL PARK EXERCISE

Part I—Field Work
Part II—Application of Field Work
Part III—Appendix (Key for classification for Ungulates)

This exercise has been set up to give you some experience in·

(a) Fitting a group of varied animals into a system of classification (Part I of Exercise)

(b) To use this knowledge to study problems in animal evolution and distribution (Part II of Exercise).

PART I

Classification of Hoofed Mammals—the Ungulates

(Participants can attempt classification of other groups of mammals in a similar way. Mammals are used for this exercise because they are large and are known to most people without a zoological training.)

Home Work

Before you actually proceed with an attempt to classify hoofed mammals of the Zoological Park it will be useful for you to look over all the other orders of mammals.

Several references have been recommended for this exercise and it is not intended that you read all those listed.

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Field Work

Step I (Equipment)

Take the following with you to the Zoological Park:

(a) Field Binoculars
(b) Field Notebook
(c) Pen or Pencil

Step II (Identify hoofed mammals)

As you go round the park look for mammals that have the end of each digit covered with a horny structure, the hoof which can be easily recognized. This is about the only characteristic the mammals in this group have in common.

Step III (Note down characteristic features in each)

After identifying hoofed mammals observe and record other characteristic features as:

(a) Number of digits in each limb.
(b) Size of entire animal as well as parts, if necessary.
(c) Presence or absence of horns and their nature.
(d) Any other characteristic features worth recording.

Step IV (Attempt to classify your data)

Proceed to frame a system of classification on lines similar to the one discussed in the laboratory on principles of classification.

Step V (Check your classification)

Check your classification of hoofed animals with the one that will be supplied to you in the Park after completion of your exercise. Make necessary corrections in your chart.

Note. No account of taxonomic system has been given here because it is assumed that you have already read one. Pages 238-254 of storer is good for this A more advanced but less complete treatment is found in Romer (1945) and a very complete advanced account may be found in pages 1-33 of Simpson (1945).

PART II

Problems in Evolution And Distribution of Hoofed Mammals of the World

(Part II of the exercise is to be done as home task)

Step I (Preparation of chart of zoogeographical regions)

Prepare a chart listing all the zoogeographical divisions of the world across the top and all the families of hoofed mammals (data of families obtained in Part I plus families noted down from textbooks) along the side of the chart as:

Zoogeographical Divisions of the World

Families of Hoofed Mammals of the World	1	2	3	4	5	6	7
Fam.							
Fam							
Fam.							
Fam.							
Fam.							
Fam.							
Fam.							
Fam							
Fam							
Fam.							

Step II (Fill in the chart)

Fill in the chart by marking the presence or the absence of every family of hoofed mammals in the various zoogeographical regions using following reference:

+ = Family *present* in Zoo-geog. region
− = Family *absent* in Zoo-geog region

Step III (Evaluating evolutionary success of various families)

From the data on your chart and from your other observations on the Zoological Garden collection, you are then to write a short account stating which types of hoofed mammals have been successful in meeting recent conditions and which have failed to do so and upon what you base your conclusions. Two assumptions may be made.

1. That the orders of hoofed mammals each originated from a different ancestral group and developed the hoofed type of locomotion independently.
2. That the wideness of the distribution of the group on the earth and the number of families the group has split into is some measure of the success of the group.

Make the account brief. Give only the evidence for your conclusions themselves. All items such as the taxonomic system, the bases for the zoogeographical regions,

the history of the problem, reasons for interest in the problems, etc., are extraneous and should be left out. Your written account, together with your chart are then to be turned into your instructor.

PART III

(*Appendix*)

Key for Identification of Families of Hoofed Mammals (Ungulates)

1. Trunk present . Order Proboscidea Elephant Family.
   Trunk absent .. ..
2. Size about that of a rabbit, no horns, body well haired
   (Order Hyracoidea) . Procavid Family.
   Size larger than rabbit . ..3
3. Centre toe or digit larger than other digits, horns absent on forehead, (Order Perissodactyla) . 4
   Two centre toes of equal size; horns usually present in male . . 6
4. Four toes on forefeet, three toes on hind feet; Nose horns absent, Tapir family.
   Less than four toes on forefeet. .5
5. Single digit on all feet; no horns on nose region; Horse Family.
   More than one digit, horn or horns present in nose region; Rhinoceros Family.
6. Legs and neck very long in proportion to body; two horns covered by skin; eat pattern consisting of large blothees;
   Legs and neck never longer than body 7 Giraffe Family.
7. One or two humps on back; Camel Family.
   Hump absent 8
8. Pig-like form with short legs, flat snout, all tusks originating from lower jaw and curving upward 9
   Form not pig-like . . .10
9. Three toes on hindfeet, white collar; Family Tayassuidae.
   Four toes on hindfeet, coat colour relatively uniform; Pig Family
10. Body extremely heavy; head broad with large mouth, legs short, ears relatively small; Hippopotamus Family.
    Body not heavy; legs usually long and graceful . . . 11
11. Size small, tusks curving down from upper jaw, no horns present, Family Tragulidae
    Horns present in male, tusks absent. 12
12. Horns curved or coiled, but never branching, Cow Family.
    Horns always branching .. 13
13. Horns in the form of highly branched antlers; Deer Family.
    Horns with a single, short rearward branch; Family Antilocapridae

FIELD STUDY OF BIRDS

The scientific field study of birds has an important bearing on human ecology and economics.

Training in field study of birds may be initiated in two phases:

First phase : Identification of birds in a locality

Second phase: Training in

a. Bird behaviour
b. Population studies
c Migration
d. Ecology
e Breeding Behaviour, etc.

Suggested Field Work

Exercise 1. Lab. course on classification of animals

Exercise 2. Field trip to a local garden or park. Describe the birds in the park. Frame key to classify the birds.

Exercise 3. Describe the birds visiting school compound. Frame a key to classify the birds in the park.

Exercise 4. Keep records of birds visiting school compound for a year. Classify them as resident birds and migrants.

Suggested References

The Book of Indian Birds—Salim Ali
Indian Hill Birds—Salim Ali
Handbook of Indian Birds—H. Whistler
Birds of Britain and Europe—Peterson

Note Suggestions for improvement in the bird identification key in this exercise are welcome

Identification of Birds in a Locality

This exercise is intended to give you training in devising a key for identification of water birds at Najafgarh Lake, Delhi.

You can identify the aquatic birds at Najafgarh lake with a fair degree of accuracy by:

Noting the location of the bird in the lake
Noting the size of the bird
Noting the characteristic colour pattern of the bird

Note the location of the bird as below:

a) Flying over water
b) Perching on a tree growing in water
c) Perching on a tree growing near water
d) Wading near edge of water
e) Wading in interior of lake
f) Swimming in water (birds other than ducks)
g) Ducks

Reference used to denote size of the bird:

Large bird—About size of vulture (+or—)
Medium bird—About the size of domestic hen (+or—)
Small bird—About the size of mynah (+or—)

Note Numbers in brackets in following pages refer to figure numbers in Dr. Salim Ali's *The Book of Indian Birds*

*a. **Flying over Water***

White Bird

a) Size: Mynah
Tail: Forked
Top of head: Black
—*River Tern* (*180*)

b) Size: Hen
Tail: Not Forked
Top of head: Greyish white
—*Black Headed Gull* (*179*)

b. Perching on a Tree Growing in Water

1. Black Bird

a) Size. Hen
Neck: Very short
Wings: Folded or open
—*Little Cormorant* (*194*)

b) Size: Hen +
Neck: Very long, slender and bent in form of 'S'
Beak: Long, slender
—*Darter* (*195*)

2. Brown Bird

a) Size: Mynah +
Back: Brownish
Head and Chest: Greenish brown and dotted
Beak: Yellow
Legs: Green
—*Pond Heron* (*209*) (Quite often seen on edge of water)

c. Perching on a Tree Growing Near Water

Brown and Blue Bird

a) Size: Mynah
Breast: White
Wing: Blue
Body: Chocolate brown
—White Breasted Kingfisher (*113*)

b) Size. Mynah–
Throat· White
Upper side: Blue
Lower side· Brown
Side of head. White
Bill: Large and Red
—Common Kingfisher (*112*)

2. Black and White Bird

a) Size. Mynah
Bill: Blackish
Body: Patches of black and white
—Pied Kingfisher (*111*)

b) Size: Hen—
Bill: Yellow
Chest and Belly. White
Back and Head: Black
—Night Heron (*211*)

d. Wading Near Edge of Water

1. White Bird

Size: Hen
Body: White
Leg: Black
Bill: Yellow
—Little Egret (*206*)

2. White and Black Bird

a) Size: Mynah+
Legs: Long and Pink
Beak: Black
Breast. White and black
—Black Winged Stilt (*185*)

3. Olive Green and White Bird

a) Size: Mynah—
Upper part. Olive green
Lower part: White
Legs: Green
—Common Sand Piper (*190*)

b) Size: Mynah+
Beak: Pink
Upper part. Grey
Lower part. White
Legs: Red
—Red Shank (*189*)

e. Wading in Interior of Lake

1. White Bird

Legs: Pink

a) Size: Vulture+
Beak: Pink
Wing tip: Pink
—Flamingo (*213*)

b) Size : Vulture+
Beak : Yellow
Wings : Streaks of white, black and Pink
—Painted Stork (*203*)

Legs: Black

a) Size: Hen+
Neck: Black
Beak: Black, long, slender and curved down
—White Ibis (*197*)

b) Size : Vulture
Tail : Black
Beak : Gap between 2 beaks
–Penbilled Stork (*204*)

c) Size : Vulture+
Tail : Black
Beak : Red
—White Stork (*199*)

2. Black and White Bird

a) Size : Vulture+
Legs : Pink

Body : Black
Neck : White
—*White Necked Stork* (*200*)

b) Wing and Tail : Black
Neck and Head : Black
Back and Base : White
—*Black Necked Stork* (*202*)

3 *Grey Bird*

a) Size : Vulture++
Top of Head : Red
Body Grey
Live in Pairs
—*Sarus* (*173*)

b) Size · Vulture—
Bash : Ash grey
Neck : White
Belly : White
Beak : Yellow
Neck. Long and bent in form of 'S'
—*Grey Heron* (*205*)

4. *Black Bird*

Size : Vulture—
Body : Black
Beak · Black and long, slender and curved down
—*Black Ibis* (*198*)

5. *Brown Bird*

a) Size : Vulture++
Neck and Head : Naked and red
Back and Belly : Dirty white
Beak : Enormous and yellow, reddish pouch hanging from neck
—*Adjutant Stork* (*201*)

f. Birds Swimming in Water
(Other than Ducks)

1. *Black Bird*

Size : *Hen*

a) Forehead : With whitish patch
—*Coot* (*169*)

b) Forehead : With red patch
Tail : Flickers
—*Indian Moorhen* (*167*)

2. *White and Black Bird*

Size : Hen—
Back : Dark
Under parts : Whitish
—*White-breasted Waterhen*

3. *White Bird*

Size : Vulture+
Long pouch between mandibles
—*Pelican* (*193*)

4. *Brown Bird*

Size : Mynah+
Body : Chocolate brown
Tail : Long, arched
—*Jacana* (*120*)

5. *Purple Bird*

Size : Hen
Tail : Flickers
—*Purple Moorhen* (*165*)

g. Ducks

1. *Black and White Bird*

a) *Comb-like structure on beak*
Back : Black
Neck : Mottled white
Belly : White
—*Comb Duck* (*214*)

b) Head : Chestnut coloured
Bill : Crimson
Breast : Black
Body : White and Brown
—*Redcrested Pochard* (*253*)

c) *Tuftfeathers at back of head*
Body : Black
Belly : White
—*Tufted Pochard* (*209*)

2. *Black Bird*

Size : Mynah+
Actively swimming and diving
—*Dabchick* (*224*)

3. *Brownish Bird*

a) Head : Pink
—*Pink Headed Duck* (*254*)

b) Head : Green
Neck : Green
Breast: White
Belly : Brown
Tail : Green
—*Shoveller* (*222*)

c) Head : Green
Neck : Green
Beak : Yellow
Neck : With white ring
Wing : Violet patch
Tail : Black
—*Mallard* (*252*)

d) Body : Orange brown
Tail . Blue
Head : Light orange
Brahminy Duck (*217*)

e) Tail : Black
Wing : White patch
–*Gadwall* (*252*)

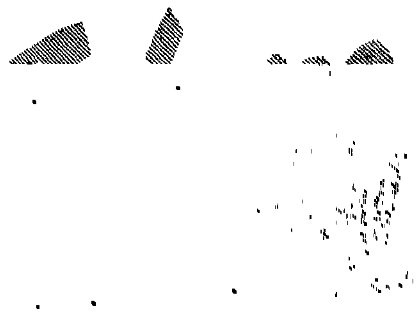
4. *Greyish Bird*

a) Tail : Pointed, long, thin
Tail : Black
Head : Brow
–*Pintail* (*220*)

b) Two prominent black bars across back of head
Tail : Black
—*Bartheaded Goose* (*216*)

c) Bill tip · Yellow spot
Wing : Greenish patch
Body ; Brownish spots
—*Spotbill* (*221*)

d) Head : Chestnut and brown
—*Common Teal* (*218*)



The History of Science in the Seventies

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Within the last few years the stately discipline of the history of science has undergone rapid fundamental changes. The full impact of these changes will not be evident for at least another academic generation; they are, in some respects, unrecognised even by practitioners today. But immediate or delayed, clearly seen or merely sensed the traditional view of isolated scholars devoting their lives to the great ideas of "intellectual heroes" who file through the ages in apostolic succession, from Aristotle to Einstein, is no longer the commanding image of the profession.

THIS is not to say that great figures and great ideas in science have diminished importance. Rather, there has been more a shift in emphasis, one of the most visible forms of which has been the rapid rise of scholarly interest in the so-called "external factors" associated with scientific growth. Ideas or inventions are no longer being seen as much in isolation as they were, but are being stressed within the social, economic, religious and political dimensions of scientific and technological culture and against the impact of science upon everyday life and leisure. Indeed, there are those who would see in this shift of emphasis a necessary phase in the development of scholarship, which is acquiring a "new relevance" of even greater significance than the "new humanism" voiced by George Sarton in the 1939's and by James Conant at Harvard after the last war. With this phase has come a new sense of exploration, and a questioning sense of urgency.

Perhaps three particularly noticeable factors have contributed to this development. One is the simple factor of size. In 1950 there were only five professional historians of science in North America, and only a few schools—notably Harvard, Wisconsin and Cornell—which offered graduate work leading to the doctorate Today, only twenty years later, there are at least 300 full-time professional members of the history of science and technology in North America, not counting 100-150 others who specialise in the philosophy of science or the history of medicine. The History of Science Society in America has today about 600 members and even the British Society of the History of Science has nearly 400. In this country, from early beginnings of University College, London, in 1925, the history of science is now taught at over 11 different universities and 30 technical colleges. Not all of these have professional historians of science, but all do contribute a growing pressure for greater definition of the profession's objectives and obligations. With growing numbers has come a greater sense of corporate purpose. Professor I.B. Cohen of Harvard, doyen of many living American historians of science was recently quoted in the New York Times as saying:.

"For a long time we worked very hard at the concept of a service profession to know how useful we were to other fields, but now there are enough members so that

we can also speak to ourselves for ourselves "

Growth in professional numbers has also made room for those who are interested in alternatives to the dominant interpretative modes of the past 20 years which have been largely guided by the vastly influenced and intellectually elegent "conceptual analyses" of Alexandre Koyre. In looking beyond Koyre's highly rationalistic view of history there has been growing interest in the evolution of science as a social system and with the relationship of science to its surrounding intellectual and social "environment". This is by no means a totally new phenomenon. Scholars since the thirties have been familiar with the social interpretations of science made famous by J.D Bernal and J B.S Haldane. At the time, much of this work was dominated by strong ideological views, which perhaps denied the subject wide scholarly acceptance, particularly in America. But in the wake of the last war and the birth of the Atomic Age, a more general human awakening momentarily raised the subject above the turmoil of conflicting ideologies. In 1948 the Director General of UNESCO asked the new Commission for the History of the Social Relations of Science to study

> "the problems arising from the interrelations of science and society in the modern world and to. . .illustrate the way in which historical studies can help in the solution of these problems."

But the scholarly response to UNESCO's mandate was disappointingly slight. Very few professional historians of science in the 1950's turned to the "social dimension of science" as an area worth cultivating for its own sake.

This picture, however, is at last changing. In a survey of members undertaken by the American History of Science Society in 1968, over 100 scholars indicated a strong interest in the "social relations of science". No comparable survey has been done in Britain, but it is perhaps significant that of the seven short papers given to the most recent annual meeting of the British Society for the History of Science at Leicester last July, at least four were concerned with the institutional and social influences of science or with the influence of communication and publishing in scientific activity.

Broadly speaking, this interest in the social studies of science has only been the most visible part of a much larger phenomena. The quest for alternatives has also become apparent in radically new conceptual syntheses and in the discovery of new forms of evidence. The "newer" history of science is greatly indebted to Thomas Kuhn of Princeton, who has dealt with great elegance upon the nature and dynamics of scientific revolutions, which he describes in terms of "gestalt shifts" between "paradigms". "Paradigms", in his usage, define the "normal science" which most scientists in a given area daily pursue; when the empirical evidence of our senses, or wavering commitment on intellectual grounds begins to erode the foundations of a paradigm the way is made for such intellectual catacysms in the firmament of science that we call them "revolutionary". Such was the replacement of the Ptolemaic universe by the Copernican and the Newtonian by the Einsteinian, so too was the Darwin "revolution" and the Freudian. There can be no doubt of Kuhn's influence, not only on the history of science, but on the academic community at large and the debate has produced promising signs of a general historigraphical awakening. While the atmosphere remains charged with controversy among philosophers about the nature of scientific method, while critics

of the "falsificationist" school of Professor Sir Karl Popper flourish the work of Kuhn and while Kuhn's critics take sides against both, historians have been obliged to explore the ramifications of this concept for the sociology of knowledge and the development of the scientific community. Some have projected a new sociological and cultural 'relativism' as a means of assisting the historical treatment of scientific ideas, a relativism derived from the nature of mutually-serviceable "knowledge claims" and overlapping paradigms. The much vaunted "objectivity" of science is being held to close scrutiny, while the role of intellectual fashion, the scientist's audience and his style of presentation, are seen to contribute significantly to what we really mean by scientific method. Increasingly, the respective roles of "justification" and "consensus" in a field and the impact of both on the generation of new ideas is being better understood by the processes through which knowledge is made "public". There is no doubt that whether in terms of everyday science or dramatic changes, studies of the social process by which new empirical knowledge or theoretical understanding can emerge have reached a new pinnacle of importance.

Much, however, remains to be done historiographically to qualify or refine broadly based methods of interpretation. Indeed, even if we have an acceptable view of broad scientific change, we have yet to reason out those "genetic" and environmental factors which have induced change in the evolution and diffusion of new and others to be suppressed beyond recall. However, the very dominance of "normal science" in nuclear energy or molecular biology, when translated into human terms, challenges the historian to explore interactions between the world of ideas and the everyday world of political and social events There can also be no mistaking Kuhn's juxtaposition of political terms with his description of scientific change. Just as the Industrial Revolution derived its name from the social revolution in France, so it is not wholly improper for science, experiencing vast upheavals, to be interpreted in similar fashion. But the association is not merely terminological. The possibility that scientific change and social change are far from accidentally associated has also prompted many to ask whether factors resisting change in an intellectual sphere are dissimilar from factors resisting change in society. It is true that political events of the 1960's coupled with greater public awareness of the "environmental revolution" and the seemingly uncontrollable devastation of technological "progress" have particularly impressed many young scholars—regardless of discipline. Historians of science have not been immune to this influence. Indeed, historians of science and technology have sometimes sensed a special responsibility to explain historical events in such a way as to throw light on imminent issues of today Undoubtedly this *prise de conscience* which swept large sections of the academic community after the events of May 1968, has contributed to a greater application in the West of the scholar's role in helping his society to comprehend the pact of science. There may be unlooked for dangers here, both because easily be dominated by the shibboleth of "relevance" and because the Jamesian "bitch goddess" of "contemporary importance" can show precious little regard for intellectual rigour and the higher demands of reflective thought that distinguishes historians' craftsmanship at its best. If historians of science become critically aware in ways that may influence

their choice of research, their conclusions, or the implications that can be drawn from their work, it is not too much to ask for efforts to ensure that social responsibility does not fall prey to an over-zealous historicism. Historians of science have here an important role to play within their own disciplines, by demonstrating that scholars can contribute to "relevant" studies of science and its social repercussions without being prodigal to their cultural and scholarly inheritance.

Just as the prevailing social climate can influence the directions in which some scholars move, so economic and intellectual opportunities will help push developments in the profession Employment patterns in the history of science, which have made dreary reading for decades, became much brighter towards the mid-60's, and for those wishing to look beyond narrow limits, the demand is still great This is happening in part because of the needs of Liberal Studies courses in polytechnics; in part because of the several "Science Studies Units" now in existence; and in part because of the increasing official use of historians of science. The "newer historiography" seen both in conceptual and empirical terms, is already being promoted by new journals and by new graduate courses. But there are important conditions to fulfil if the profession will flourish. The history of science must, for example, draw closer to the study of general history, and not lose sight of the place of social, economic and institutional developments which have influenced ways in which science and technology have been received

In some ways a link is already being forged with science can only benefit from this association For example, one of the earliest and most notable contributions to the social study of science was the work of R.K. Merton, the American sociologist whose *Science, Technology and Society in 17th Century England*, first published in 1938 called upon Weber's hypothesis of a driving "protestant ethic" and the selective influence of economic demands to help explain the circumstances surrounding the Scientific Revolution. Although this work masked certain fundamental oversimplifications, it has stimulated sociologists and historians to come to grips with larger historiographical issues. Moreover, the work of Merton in the 40's amplified in the late 50's and early 60's by Bernard Barber and a small school of interested sociologists at Columbia, has generated much interest in the conduct of scientists in establishing communication patterns, and in seeking rewards. To this analysis, the history of science can make its own contribution It is generally believed, for example, that current "sociology of science" has predicated many of its conclusions on ideal-typologies that may be said to constitute the value system of recent Western science. This preoccupation, however, has sometimes led to the neglect of factors which illustrate radical changes in the character of science over different periods of time and across different cultural boundaries There is some distance to go before "scientific norms" can be wielded interpretatively by historians, but as and when historians and sociologists join forces, it will become possible to draw fresh inferences about such phenomena as the role and impact of scientific publishing, the determinants of intellectual mobility and the effects of economic incentives on particular innovations, instruments and schools of thought.

Of course, this cross-disciplinary impulse will not achieve its potential effect unless historians of science generally become more tolerant of alternative methods and

approaches to the study of science Because science has both an autonomous intellectual character, and a broad set of social relationships, there can naturally be dramatic differences in motivation and object; this has given rise to the so-called distinction between "internal" history of science and "external" history of science However, this expression, which has become almost a cliche within the profession, has the air of an easy conundrum more impressive in appearance than in reality There will remain a fundamental distinction between analytic philosophical study of ideal methodology and the study of essential ideas events and men, and a distinction based on this principle will undoubtedly persist between philosophers of science and historians of science. But within history itself, alternative historiographies will develop, strengthened not only by an enriched sense of context but also modified by discoveries in linguistics and social psychology. Other historiographies will probably follow in the wake of efforts to encourage scientific activity in "Third World" cultures, where the linguistic and psychological forces contributing to the dynamic, competitive, yet coordinative instincts seemingly inherent in research are explicitly absent It is not visibly clear whether developing countries, confronted by social, economic and technological needs vastly different from many of those familiar to Europe, need necessarily undergo the same experiences of scientific development that Europe has undergone; indeed, this probably cannot be the case, if only because "new" countries are hurting into the scientific "league" with such speed that the historical sequence of Western scientific change has little relevance to them. The study of scientific change in cultures which until recently lacked the economic, social, urban and industrial culture we associate with scientific development, undoubtedly holds in store some of the richest treasures of evidence the future historian of science can hope to find. Finally, cross-disciplinary work will enable the historian to explore, with much greater precision, the dynamic relationships existing between research and development. The common place occurrence of technological, economic pay off has prompted lengthy enquiries into these relationships and considerations about "environmental" policy and the "quality of life" will doubtless bring them even greater prominence. The broad macrocosmic descriptions generated in the 20's and 30's and still heard today, are giving way on several fronts to carefully constructed empirical analyses of particular cases of development. With more case studies at hand it may be possible, for example, to draw generalisations for industries which were endowed with science from the beginning or which added science to a legacy of craftbased tradition. Growing economic interest in showing what linkages do in fact occur over different intervals has already attracted the Department of Defence, through "Project Hindsight" and the National Science Foundation, through "Project TRACES". Recent micro-economic analyses of different science-based industries are beginning to show what factors, implicit in a particular industry's development, militate against rapid innovation, or make the difference between "success" and "failure" in the world market place. The historian of science has here the notable challenge of pursuing his knowledge of science through all steps in the process of innovation.

Either way, the dimension added by scientific knowledge to the industrial development of new corporate structures, management techniques, an educated workforce and other phenomena visibly enriching and

troubling our technological society, will give the historian of science much more freedom of choice and manoeuvre than he has hitherto recognised. Indeed, without diminishing the philosophy of science, the history of particular sciences or the history of invention, careful choice of alternatives may find the social characteristics of science and technology and the social roles of scientists and their institutions blended in a broader conceptual context which will help us do our only real job—to "make sense of the past".

Deadly Venom from Mini-Octopus

The venom secreted by the salivary glands of the tiny but deadly blue-ringed octopus (*Hapalochaena maculosa*) is probably more toxic than that of even the most dangerous snakes and spiders.

A team of neuro-physiologists led by Dr Peter Gage is studying the toxin of this mini-octopus and its effects on the human nervous system at the University of New South Wales. The poison was found to have highly unusual characteristics and differs from all other known poisons. Its unusually low molecular weight has so far prevented the preparation of an anti-venene by ordinary methods.

Nevertheless, the Australian neuro-physiologists have deduced from their research that people bitten by this small creature would stand a better chance of survival if they were immediately placed under sedation or even anaesthetised. This is because the neuromuscular functions threatened by the venom block faster if the nerves of the body are repeatedly activated as they are when the victim is fully conscious and moving about Under sedation, the full effect of the venom would be delayed sufficiently for the poison to be diluted to a level that would not endanger life.

The blue-ringed octopus has already caused a number of deaths around the Australian coast. Victims are attracted by the colourful little creature and pick it up in their hands for a closer look Most people are not aware of having been bitten. However, within a few minutes they feel a tingling sensation around the mouth. Numbness then develops about the face and neck and breathing becomes difficult Death follows paralysis caused by blockade of nerve impulses

Although this research may well lead to the discovery of an antidote to the venom of the blue-ringed octopus, Dr. Gage and his colleagues believe that other long-term possibilities are of even greater importance The effects of this unique toxin on transmission of messages along nerves suggest that knowledge of its chemical structure may provide a lead for the production of a new class of anaesthetics Attempts are being made to determine its structure, and it is hoped that it may ultimately be synthesised in the laboratory

The researchers are now studying certain effects of the venom on the giant nerves of the squid. At present they are finding plenty of the deadly octopuses in tidal rock pools, under rock ledges, and ometimes even in abandoned shells on the coastline around Sydney.

The blue-ringed octopus is also found in the Indian Ocean, Ceylon, and Japan.

Courtesy · Australian Information Service

Science Looks at the Buffalo

Throughout the world the water buffalo (*Bubalus bubalus*) has been thoroughly

domesticated. Only in Australia, on the coastal plains of the Northern Territory, can large colonies of feral buffalo be found and the social behaviour of the species in its wild state be studied.

Preliminary observations on the natural behaviour of buffaloes conducted by a biologist, Mr D.G. Tulloch, of the Animal Industry and Agriculture Branch of the Northern Territory Administration, Darwin, have shown that many popular notions about these beasts are erroneous. Thus, it now appears that contrary to widespread opinion, the buffalo lends itself to domestication even more than cattle.

They are innately placid in temperament, only becoming nervous in the presence of strangers and distraught when removed from familiar surroundings. Their homely instincts were demonstrated by enclosing a wild herd in a paddock. After only a few weeks during which they were handled by only one person they became quite placid in his presence, but reverted to aggressive behaviour when strangers appeared. Moreover, they would not leave the area when given their freedom and encouraged to move away.

Observations on wild, marked animals have shown that family groups form and adopt a locality as their home range which they are very loath to leave. This strong territorial instinct and reluctance to move is so great that it sometimes has disastrous consequences. For instance, buffaloes on the coastal plains often perish needlessly rather than move a few miles when the feed or water within the self-imposed boundary of a group run out. This attitude is stronger among the females than the males.

In their social activities wild buffalo exhibit behaviour patterns very much like those of the red deer (*Cervus elaphus*) and the Soay sheep of Hirta. When domesticated, adult males and females will tolerate each other's company throughout the year and live contentedly in mixed herds

However, in the wild state, the females form small groups with their calves and the immature males, and will only accept adult bulls during a breeding season. The reason for this extraordinary behaviour is unknown because domesticated buffalo cows come into oestrus regularly and can conceive at any time throughout the year. Likewise under domestication the bulls can be sexually active all the year.

Among the feral colonies in the Northern Territory the breeding season is confined to the wet season and sexual activity occurs most frequently during the early part of the wet. At this time, the bulls go to the cows even though they range superior grazing to that occupied by the cows

Dominant bulls form harems and aggressively exclude bachelor bulls. Much fierce fighting ensues during this period whereas during the rest of the year the adult bulls live peacefully together in groups away from the areas In fact, bulls attempting to join the cows out of the breeding season are vigorously repelled.

The world buffalo population probably exceeds 100,000,000 scattered throughout some 20 countries. The Food and Agriculture Organisation of the United Nations is concerned that this vast herd, which is almost entirely closely husbanded, is not nearly as productive as it might be. Low fertility is one of the main reasons for the poor harvest of animal products obtained from this species which science has largely neglected until lately. It is hoped that the Australian studies will throw some light on this and other aspects of buffalo husbandry.

FAO research financed by Australia has already demonstrated that buffaloes

can utilise poorer quality feed than cattle. This accords with local Australian observations that during drought, when buffaloes and cattle are grazing the same area, the cattle become emaciated and begin to die long before the buffaloes show signs of stress. Moreover, the amount of meat that can be out from a well-grown buffalo carcass is greater than can be obtained from the best cattle.

The buffalo is a profoundly important link in the agricultural economy of many countries with hundreds of millions of people depending upon it. Being the tractors of the East, they are the mainstay of rice producing. Hence when a killing disease such as renderpest or a crippling one, such as foot and mouth, strikes at sowing or harvesting time, crops are lost for lack of power.

Australian scientists have become more concerned about disease control in buffaloes recently partly because if an exotic disease broke out among the feral herds it would spread to the highly susceptible cattle population causing incalculable losses. It was discovered about two years ago that a migratory bird from Asia visits Australian buffalo herds for part of each year. This bird is apparently like the rhinocerous bird in that it uses the buffalo as a means of obtaining appropriate food The risk in this intimate association is that the birds could carry disease from the buffaloes in Asia to those in Australia and hence to the cattle.

Vaccines prepared to produce immunity against certain diseases in cattle are only partially effective in buffaloes, although these animals are even more susceptible to rinderpest, anthrax, haemorrhagic septicemia and foot and mouth disease than cattle.

With science now taking a greater interest in buffalocs, hopefully, this important species will begin to make an even greater contribution to mankind Australia has already begun to domesticate and exploit its 200,000 buffaloes but the programme is hampered by the lack of knowledge of the buffalo as a species and as a grazing animal.

How Nerves Make Muscles Contract and How the Nervous System Adjusts to Age

JOHN NEWELL

The awarding of the 1970 Nobel prize for medicine jointly to a British, Swedish and an American scientist for their work on conduction in nerves, highlights the renewed interest and progress in neurology. The prize was shared between Sir Bernard Katz, Ulf Von Euler and Julius Axelrod, for their work on the way in which nerves stimulate muscles into action The importance of the work is not limited to this, it also helps to explain how messages are passed from one nerve cell to another -- the basis for all mental activity

ORIGINALLY it was thought that the signal which passes from a nerve to a muscle was electrical, but over the past few years it has become clear that, rather suprisingly, the signal is actually chemical Between them the Nobel prize winners have shown exactly what this chemical signal is and how it is sent When a message is sent from the brain down a nerve, a change takes place in the electrical properties of the membrane surrounding the nerve. This change, which runs down the whole length of the nerve, appears to be both electrical

and chemical. But where the nerve ends in the so-called end plate, where it joins a muscle, the signal is translated into a chemical signal, in fact into the release of tiny quantities of acetylcholine which move across the gap between nerve and muscle and stimulate the muscle to contract.

Professor Katz's contribution was to show that acetylcholine is only liberated in very precisely defined and constant quantities, which he nick-named quanta He and other scientists also showed how acetylcholine is stored in the ends of nerves, while it awaits the stimulus required to send it across the gap to the muscle. The same quantum mechanism is used to carry nervous messages across the junction between two meassages across the junction between two nerve cells, in the brain or elsewhere. The situation here is more complicated, acetylcholine is not the only transmitter substance involved and there are also inhibitory compounds produced to cut down the case of transmission. But the same basic method of bridging the gap is used. This research is too new to have any application as yet However, scientists working in the field hope that eventually it will help doctors to find new ways to treat common forms of which are caused by a failure communication between nerves and muscles.

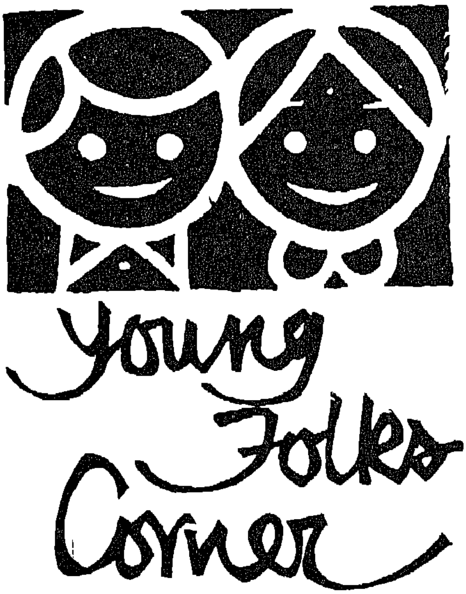
Another scientist working on the transmission of messages from nerves to muscles has very recently shown how the system adjusts to human ageing. As we grow older, the number of the end plates connecting nerves and muscles increases. This is the discovery of Dr. Alan Tuffery, of Durham University's department of Zoology Until Dr. Tuffery developed new techniques for examining nerve end plates, doctors had believed that when a nerve puts out new branches to join it to a muscle this was a symptom of some kind of nervous disease Dr. Tuffery showed that this branching took place throughout the adult life of completely healthy animals and human beings.

Dr. Tuffery believes that this increase in end plates compensates for the weakening of the nervous system with age. The consequent increased stimulus is necessary as we get older, for three reasons. First, our body weight usually increases, so our muscles have to work harder all the time. Second, the signals sent down nerves from the brain may become weaker with age. And third, some of our muscle fibres are continually being lost and not replaced as we get older So our limbs have to work harder all the time and the only thing that will make them do so is a bigger stimulus from the nervous system

One apparent error in this reasoning is that, by ordinary logic, it seems impossible to increase the stimulus given to a muscle by nerve simply by multiplying the number of connections One would expect that the result would be to cut down the power of the original stimulus as it was subdivided into smaller and smaller parts. However, this seems to be overcome by some mechanism still unknown, by which the impulse is doubled whenever a nerve divides. This means that the original stimulus is preserved and travels on down each branch. The effect of further division in the nerve branches is to multiply the stimulus!

From this research it may be possible to find ways of stimulating nerves to form new connections with muscles, to replace those lost with age or illness. The first step, however, is to understand how the nervous system performs the same tasks naturally. Dr Tuffery's work should eventually have great significance for practical medicine.

Reprinted from *Spectrum*, **80**, 1971



Improving Work-Experience in Science

W.P Kurchania
State Institute of Science Education
Jabalpur

THE nature of science today is perhaps more sharply revealed if we compare it with its earlier phases. The old philosophers were also systematic observers of natural phenomena. Unfortunately, the interpretations of nature stated by Plato, Aristotle and others were accepted unconditionally in the middle ages as irrefutable laws. Science became merely an extended search for more absolute truths Once arrived at, such absolute truths were taken as statements from authority. This inhibited and even literally blocked free and searching inquiry for centuries

It was in the sixteenth century when Galileo departed with the authoritarian science and opened the gates to new experimentation Newton, Priestley, Darwin, Macwel and many others followed deriving new laws that stood on a foundation of objective observation and analysis

Nature of Laboratory Work

Science education was influenced by the heritage and laboratory work became merely exercises to verify laws and rules Also there are some who consider laboratory work as showing the practical side of science, divorced from and having less prestige than the theoretical part This approach helps to develop in students the sense of excitement that comes from discovery, from taking observations, forming new generalisation and perhaps a new theory. In fact, the laboratory provides the students with an understanding of procedures for scientific investigation, including control of certain variables, careful observation and recording of data and the development of conclusions. The study of science through laboratory work serves two purposes: the student learns the concepts and facts of science itself and in addition learns how to grow in his knowledge and understanding of science. The laboratory experience in school, therefore, should be investigatory rather than just illustrative in nature.

Objectives of Practical Work

Science mainly deals with facts, their inter-relations and their applications. The objectives of teaching or learning science involve knowledge, its understanding and application; development of related skills and interest in the subject. Doing with one's own hands leads to better under-

standing about the process and will enable students to apply them to other situations It naturally develops interest and appreciation. The development of skills and other personality qualities such as regularity, systematisation, neatness, etc., are best achieved by the practical work done in the science laboratories These are various types of skills involving dissectional skill, collection skill, observation skill, manupulative skill, etc. Besides these, laboratory experience can be useful in developing scientific attitude and investigatory approach in solving problems.

Organisation of Work-experience

The work-experience in school science may be organised as (i) part of laboratory exercises and (ii) preparation of charts, models, specimens, etc., or solving investigatory projects in form of activities of science clubs. The laboratory exercises in the class should be put before the student as having an investigatory approach rather than having a confirmatory one. To take an example "Verification of Archimedes Principle" may be put somewhat like this: "To find out the difference in weight if a body is immersed in liquid." Such an approach will not only motivate the students for continued learning, but it will give them substantial practices in the process of problem solving

Needless to say that improving work-experience in science needs a well-equipped laboratory. But more important than this is resourceful teacher who makes best use of the local resources and improvises apparatus with their help, if need be. The laboratory work should be spread throughout the session and need not be concentrated hurriedly towards the end of the session. Similarly, science club activities should be evenly distributed throughout the school year and the pupils be given opportunities to work out in concrete form the ideas that strike them A proper record of the work done by the pupils should be kept.

Practical Examinations in Science Subjects

It is an admitted fact that all the organisers and teachers get impetus and organise their work according to the system adopted by the board for examining the candidates. The way of practical examinations are planned and conducted by the examining agency is bound to affect instructional practices in the schools and the work habits of pupils

A critical analysis of practical examination reveals a number of shortcomings. Poor sampling of skills, inadequate number of laboratory exercises, emphasis on knowledge of skills, disproportionate weightage to the various content areas, repetitive nature of exercises, inappropriate directions, lack of uniform instructions to the examiners, absence of detailed marking scheme, lack of systematic procedure of observation of skills, doubtful validity of viva-voce and independent assessment of sessional work are some of the glaring weaknesses of our practical examinations.

With a view to improving practical examination, it is desirable that the broad objectives be clearly defined in terms of pupils' behaviour in the syllabi of sciences Along with the list of the exprments to be performed the processes and products of performance to be emphasized may also be shown. In order to develop spirit of enquiry amongst the pupils, a few open-ended experiments may be included in the list of experiments Number of exercises with practical examinations should be increased with a view to having a good coverage of skills and different content areas.

The examiners should be supplied with detailed instructions for conducting examination and check lists, rating scales, etc., to keep up reliability, validity and uniformity in the examination.

It is further emphasized that a regular assessment of pupils' work in the science club activity be organised by the Principal and the science staff in every school. Continuous evaluation of practical work would provide the necessary motivation to pupils to pay regular attention; thus improving their study habits.

New Trends in Science Education

SUMMER SCIENCE INSTITUTES, 1971
(For School Teachers)

(Jointly sponsored by University Grants Commission, National Council for Science Education and National Council of Educational Research and Training)

Director	*Location*	*Region*	*Duration*
	BIOLOGY		
Principal G Misra	Gangadhar Meher College, Sambalpur	Orissa, West Bengal, Assam, NEFA, Manipur, Tripura, Nagaland	10 May-19 June
Prof. G P. Sharma	Department of Zoology, Panjab University, Chandigarh	Chandigarh, Punjab, Haryana, Jammu & Kashmir, Himachal Pradesh, Delhi	1 June-5 July
Shri K K. Easwaran	M.G M College, Udipi	Mysore, Kerala	3 May-13 June
Dr. V. Hari Rao	Jamal Mohamed College, Tiruchirapalli	Andhra Pradesh	10 May-19 June
Dr. Ravi Prakash	Holkar Science College, Indore	Madhya Pradesh Rajasthan	7 May-18 June
Dr D D Wani	M.E.S. College, Poona	Maharashtra, Goa	28 April-7 June
Prof. J J Shah	Department of Botany, Sardar Patel University, Vallabh Vidyanagar	Gujarat	1 May-11 June
Prof. P.J Sanjeeva Raj	Madras Christian College, Madras	Tamil Nadu, Pondicherry	28 April-7 June
Dr V P Agarwal	D.A V. College, Muzaffarnagar	Uttar Pradesh, Bihar	17 May-27 June
Shri R K Bharatiya	Regional College of Education, Ajmer	Teacher-Education (All India)	20 May-28 June
	CHEMISTRY		
Dr. P S. Radhakrishnamurti	Khallikote College, Berhampur	Orissa, West Bengal	17 May-27 June
Dr N V. Karbelkar	Vidarbha Mahavidyalaya, Amravati	Maharashtra, Goa	3 May-12 June
Prof. S P Shanmuganathan	Pachaiyappa's College, Madras	Tamil Nadu	3 May-12 June

Director	Location	Region	Duration
Shri B.S. Bahl	D.A.V. College, Jullundur	Punjab, Jammu&Kashmir	1 June-15 July
Prof G.D. Tiwari	V.S.S.D. College, Kanpur	Delhi, Western Uttar Pradesh	14 May-24 June
Dr. S.G Harmalkar	Holkar Science College, Indore	Madhya Pradesh	17 May-28 June
Dr. P K. Talukdar	Cotton College, Gauhati	Assam, NEFA, Naga-land, Manipur, Tripura	31 May-10 July
Dr R.N Kapoor	Department of Chemistry, Jodhpur University, Jodhpur	Rajasthan	10 May-19 June
Prof. Thangammani Amma	Government Victoria College, Palghat	Kerala	5 April-17 May
Prof M N. Sastry	Department of Chemistry, Andhra University, Waltair	Andhra Pradesh	10 May-19 June
Prof H.R Dave	R.P T.P. Science College, Vallabh Vidyanagar	Gujarat	3 May-12 June
Prof S.R Rao	Regional College of Educa-tion, Mysore	Mysore	3 May-12 June
Prof. L R. Ganesan	Madura College, Madurai	Tamil Nadu	9 May-12 June
Prof R D Singh	St. Andrew's College, Gorakhpur	Eastern Uttar Pradesh Bihar	17 May-27 June
Prof. K.C. Malhotra	Department of Chemistry, Himachal University, Simla	Haryana, Himachal Pradesh, Chandigarh	14 June-24 July
Prof V K Phansalkar	Department of Chemistry, Poona University, Poona	In-service (week-end) teachers of schools in Poona	1-7-71 to 28-7-71

MATHEMATICS

Director	Location	Region	Duration
Prof. S P. Nigam	D.A V. College, Kanpur	Uttar Pradesh	25 May-5 July
Prof. M R Puri	Department of Mathematics, Jammu University, Jammu	Jammu & Kashmir	10 May-20 June
Prof Augustin Konnully	St. Alvert's College, Ernakulam	Kerala	26 April-20 June
Dr M C Gupta	Department of Mathematics, Maharaja's College Campus, Jaipur	Rajasthan	16 May-19 June

Director	*Location*	*Region*	*Duration*
Prof. R.D Bhargava	Department of Mathematics, Indian Institute of Technology, Bombay	Maharashtra, Goa	3 May-12 June
Prof. Nand Kishore	Khallikote College, Berhampur	Orissa, West Bengal	10 May-20 June
Dr L Radhakrishnan	Department of Mathematics, Shivaji University, Kolhapur	Maharashtra	6 May-16 June
Principal C.L Arora	D.A.V College, Amritsar	Punjab	24 May-3 July
Shri K.N. Mehra	M.G M. Engineering College, Jodhpur	Rajasthan	10 May-19 June
Mr K Madhusudana Rao	Hindu College, Machilipatnam	Andhra Pradesh	6 May-16 June
Prof V Krishnamoorthi	Shri Pushpam College, Pondi (Thanjavur District)	Tamil Nadu	3 May-12 June
Dr. Harswarup Sharma	Agra College, Agra	Uttar Pradesh	20 May-30 June
Dr. C.B.L Verma	Government College, Jagadalpur	Madhya Pradesh	10 May-19 June
Principal N.R. Kulkarni	R.K T. College, Ulhasnagar	Maharashtra	26 April-5 June
Principal N D. Desai	R.P.T P. Science College, Vallabh Vidyanagar	Gujarat	3 May-12 June
Dr Avtar Singh	Department of Mathematics, Punjabi University, Patiala	Punjab, Haryana, Himachal Pradesh, Chandigarh	17 May-25 June
Dr P C Vaidya	Community Science Centre (C N. Vaidya Hostel), Gujarat University, Ahmedabad	Gujarat	6 May-10 June
Prof. D.V Koranne	S B.E.S. Science College, Aurangabad	Maharashtra	3 May-12 June
Prof. R.S Mishra	Department of Mathematics, Banaras Hindu University, Varanasi	Eastern Uttar Pradesh	24 May-7 July
Shri L.N. Chakravarthy	Yuvaraja's College, Mysore	Mysore	4 May-14 June
Dr. K.S. Sinha	D.A V College, Dehradun	Western Uttar Pradesh	21 May-1 July
Prof. A.C. Srivastava	Department of Mathematics, Dibrugarh University, Dibrugarh	Assam, NEFA, Manipur, Tripura, Nagaland, West Bengal	13 June-17 July

Director	*Location*	*Region*	*Duration*
Prof B S Fadnis	Department of Mathematics, Nagpur University, Nagpur	Madhya Pradesh	10 May-18 June
Dr V Verma	National Defence Academy, Kharakvasla, Poona	Sainik Schools (All India)	7 June-17 July
Dr. J N Kapoor Dr. D.K. Sinha	Department of Mathematics, Meerut University, Meerut	Curriculum Development in Mathematics Education (mathematics teachers of Training Colleges—All India)	10 May-19 June
	PHYSICS		
Prof. T B. Thomas	Union Christian College, Alwaye	Kerala	20 April-29 May
Prof B S Sood	Department of Physics, Punjabi University, Patiala	Punjab, Himachal Pradesh, Haryana, Jammu & Kashmir, Chandigarh	5 May-10 June
Dr. R.R. Mehrotra	Digambar Jain College, Baraut (District Meerut)	Uttar Pradesh, Bihar	20 May-30 June
Dr. H Narasimhaiah	National College, Bangalore	Mysore	3 May-10 June
Dr G A Savari Raj	St. Joseph's College, Tiruchirapalli	Tamil Nadu	19 April-29 May
Principal S P Sinha	T.N College, Bhagalpur	West Bengal, Assam, Manipur, Tripura, Nagaland, NEFA	19 May-29 June
Prof. P S Vardachari	Madura College, Madurai	Tamil Nadu	9 May-13 June
Dr J.C. Palathingal	Madras Christian College, Madras	Tamil Nadu, Kerala	20 April-1 June
Prof. P D Premaswarup	Andhra University Postgraduate Centre, Guntur	Andhra Pradesh, Orissa	26 April-5 June
Prof G. R Singhal	Government Science College, Gwalior	Madhya Pradesh, Rajasthan	17 May-26 June
Prof D.V. Badve	Fergusson College, Poona	Maharashtra, Goa	26 April-5 June
Prof A R Patel	Department of Physics, Sardar Patel University, Vallabh Vidyanagar	Gujarat, Southern Rajasthan	1 May-11 June
Dr S.N. Dutta	Regional College of Education, Ajmer	Teacher-Education (All India)	17 May-11 June

Science Notes

Some Thoughts on the Importance of Studying Environmental Sciences

R. Misra

Dean of the Faculty of Science
Banaras Hindu University

Education all over the world has endeavoured to improve the quality of human life. Generation, diffusion and application of knowledge have been the principal tools in renovating society. Such activities have brought us to the modern era of science and technology.

The proliferation of our cultural and material requirements has resulted in the accelerated exploitation, both in quantity and quality, of the natural resources. Many more things of our planet are being used today than a few years before. Their collection and processing lead to inevitable disturbance of the arrangements which were set by natural factors through the millenia. As coal and petroleum are being burnt, man is also producing many newer combinations of elements which in turn are changing the environment and thus imperceptibly but definitely damaging our life support system

It took nearly three and a half billion years for mother earth to prepare the stage for the arrival of man. The early hostile environment was gradually tamed with the origin of life. The evolution of the green plant by its photosynthetic activity produced oxygen of the air and channelled solar energy through food for the evolution of other organisms. This was followed by rapid diversification of organisms with the interplay of their genetic material and the environment. The flow of energy and recycling of minerals and water through the biological system created new ecosystems with compatible organism-environment complexes. Organic matter accumulated in the form of coal and petroleum leaving adequate balance of oxygen in the air. The biological community system including the decomposer micro-orgranisms maintained an ideal environment for man to evolve and live in this world. But we suddenly discover that increased human needs and a rising population are upsetting the plan of nature and the human species is threatened with extinction because we are dumping harmful substances in our environment that tend to destroy those supporting life. The currents in the air and the ocean circulate. The problem is indeed global.

Integration of knowledge derived from different fields of specialisation require systems analysis and constant modelling. Many of the universities in the western world have organised departments of natural resources and environmental sciences. President Nixon's policy statement of January

1970 and celebration of 'earth day' on April 22 in U S.A. have emphasised the importance of such studies The UNESCO seminar and symposia held on "Man and Biosphere" in 1969, the International Biological Programme, 1967-72, the impending inter-governmental meetings of the UNO at Stolkholm in 1972, the activities of the International Union of Nature Conservation and Natural Resources, etc., all lay special emphasis on the need to educate our race in the importance and study of environmental sciences. The preamble of the second chapter of our fourth Five-Year Plan gives a long-term perspective on the quality of environment.

The science of biology in relation to the environment or ecology is a complex study demanding knowledge of several disciplines. Very few universities in India are involved in ecological studies and the teaching of the subject is done superficially in some as part of a botany or zoology course Since ecology cannot be pursued through the traditional universities courses it is time that our universities plan to organise inter-departmental institutes of ecology so that both resources and expertise may be fully utilised. Multidisciplinary courses would involve certain aspects of biology, forestry, agriculture, soil science, public health, sanitation, meteorology, climatology and geography, etc. A course in Resources Ecology is presently being given at Banaras Hindu University with the cooperation of five different departments.

More or less a degree course on environmental science should take into account the following core themes:

Associated evolution of life and environment; evolution of man and his culture and his impact on renewable (biological) and non-renewable (physical) resources; basic principles of ecology including population ecology and succession; flow of energy and cycling of minerals in the ecosystem; principles of production ecology; conservation vs. maintenance of environment; soil, water and air as natural resources being conditioned by vegetation and animals and polluted by technological activities of man; technology of purification of environment; the problems of urban and rural life; the problems of population explosion vs. green revolution in the context of environmental changes, human ecology and sociology

The emphasis on certain topics or their further elaboration will naturaly depend upon the fields of specialisation of the teachers and resources at their command.

We and Our Environment

ONE of the main aims of the International Nature Conservation Year, was repeatedly to attract the attention of the youth to the dangers of neglecting the environment.

In line with this principle, the Hague Museum for Education has set up an exhibition "We and our environment".

Much thought has been given to air and water pollution, soil erosion, changes in landscape and the influence of pesticides. The effect of exhaust gases on birds, crops and trees has been attractively displayed.

A series of demographic maps, which can be activated by push buttons, show the growth of the population and the urban expansion since 1950. All models are mobile.

One of the most impressive parts is a woodland, as fresh and beautiful as the

Reprinted from *The Netherlands*

Dutch country site in spring A collection of birds accompany the visitors by chirping and singing, as if warning man, woman and child, that if nothing radical is done to protect them against the dangerous fumes and liquids, the overdose of technology, they will never be heard again.

The exhibition ends with a stork farm, where a beautiful stork gives the impression of strolling majestically, a sort of reminder that there are only 22 of them left in the Netherlands and they will soon join the perished dodo, if not given a fair chance of survival

The exhibition remains open till May 17 The museum expects some 10,000 children and youth from many schools, papas and uncles to follow suit

Report on the First Asian Congress of Nutrition Hyderabad

(January 28-February 2, 1971)

THE First Asian Congress of Nutrition was held at Hyderabad between 28 January and 2 February 1971. The Congress was sponsored by the Nutrition Society of India and the Indian National Science Academy under the auspices of the International Union of Nutritional Sciences. Dr. C. Gopalan, Direcotor of the National Institute of Nutrition, Hyderabad, was the President of the Congress and Mr. A.H Boerma, Director-General, F.A O., Rome, delivered the keynote address. The Congress was attended by 181 regular delegates and 61 student delegates. The following countries were represented:

Afghanistan
Burma
Carribean
Ceylon
Egypt
Finland
India
Indonesia
Iran
Israel
Italy
Japan
Lebanon
Nepal
New Guinea
Philippines
Switzerland
Thailand
United Kingdom
U S A
Yugoslavia

The main theme of the Congress was "Nutrition and National Development". The subjects discussed at the ten symposia covered a wide range of topics of common interests such as

Agricultural Development and Nutritional Needs; Nutrition Programmes for Children; Nutrition and Family Planning; The Role of Food Technology in Combating Malnutrition; Ecology of Malnutrition; Aspects of Vitamin Nutrition; Food Consumption Patterns; Aspects of Protein, Nutrition; Metabolic Response to Protein Malnutrition and Special Nutritional Problems of Asia Besides these symposia, 18 special reports and over 100 research communications were presented.

The scientific programme of the Congress had generated great interest among the participants who included a variety of specialists such as nutritionists, medical and public health workers, agricultural scientists, demographers, sociologists, administrators, policy-makers and planners. The achievements of the Congress were pooling of the scientific knowledge on problems of malnutrition and forging a common front of allied disciplines to evolve an intergrated approach towards the eradication of malnutrition. The Congress helped to highlight the bottlenecks in the nutritional rehabilitation programmes currently in operation in Asian region as also to provide useful guide-lines for formulating a nutri-

tion-oriented agricultural and food policy at a national level.

According to almost all the delegates, the Congress was a great success from the organisational, academic and practical points of view. Some of the important nutritionists from the Asian region who attended the Congress were K. Mahadeva and C.C. De Silva (Ceylon), C.R Pascual (Philippines), Kamdhorn and A. Nondasuta (Thailand), Poorwo Soedarmo (Indonesia), N. Shimazono and T. Oisa (Japan). The other eminent nutrition scientists who participated in the Congress were H.N Munro, C.G. King, D.M. Hegsted, W.H. Sebrell, P. Gyogry, N.S Scrimshaw, D.B. Jelliffee, P. Roine, G Arroyave, J.C Waterlow, D.S. McLaren and K L. Blaxter

At the concluding session of the six-day Congress, it was decided to hold such a Congress once in three years A steering committee was constituted for the purpose and Dr C Gopalan was unanimously elected as Chairman of the Steering Committee. It was also decided to set up a permanent machinery to develop collaborative research programmes on problems of malnutrition common to the Asian region

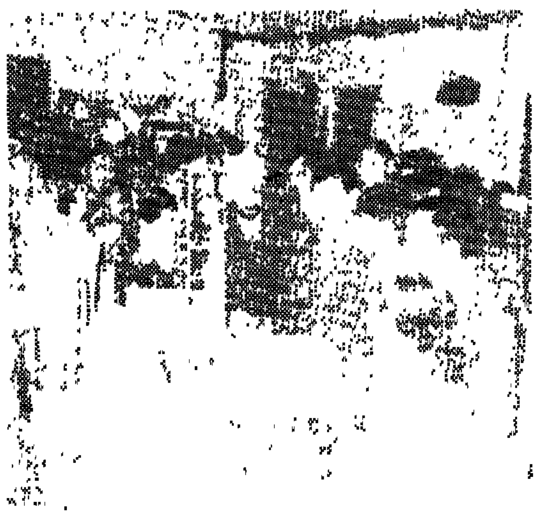
Science Club and Science Fair at State Level

A NETWORK of science clubs has been spread all over Haryana. The science clubs are encouraging the students in improving apparatus, performing interesting experiments and practising scientific hobbies besides preparation of albums and making collections of objects of scientific interest.

To encourage the young students to show and explain their exhibits to the public, science fairs were held at State level all over Haryaan from October to December 1970. About 30 selected teams from all over Haryana participated in the science fair held at the State Institute of Science, Haryana, Karnal from 19 to 21 January 1971. Dr. N.C Gangoli, Professor and Head of Dairy Chemistry Department, National Dairy Research Institute, Karnal, inaugurated the fair, and in his speech he stressed that the students of our country are as intelligent as children of any other part of the world but what they lacked was the proper environment of growth as scientists. It was therefore essential for the State Government to provide facilities for the purpose. He further appreciated the initiative taken by the State Institute of Science, Haryana, Karnal for providing facilities to the young scientists of tomorrow who showed their skills and abilities through their exhibits in the science fair A team of eminent scientists drawn from the research institutes and local colleges evaluated the exhibits.

In the evening of 19 January 1971 a Science Declamation contest was held under the presidentship of Shri R.N. Chanana,

Dr M C Gangoli of N.D R I , Karnal, with Dr. Har Krishan Singh, Director, watching the exhibits in the Science Fair



Students and Teachers Visiting Science Fair

Principal, D.A V Girls Training College on the various topics of science. As many as 59 speakers from different schools of Haryana participated. Prof M.K. Jain of National Dairy Research Institute, Prof. Rena of Dyal Singh College and Dr. Bhardwaj of Salinity Research Institute acted as judges

Prize distribution function was held in the State Institute of Science, Haryana, Karnal in the evening on 21 January 1971. Chaudhry Meru Singh, Education Minister, presided over the function. He praised the efforts put in by the students and their teachers in preparing their items He also praised the efforts put in by the State Institute of Science in organising the fairs. He stressed on the need of science fairs and other similar activities for furthering the cause of science education in the State and promised all help from the State Government in this direction. He gave away the shields, prizes and merit certificates to winners in the science fair

Science Club of State Institute of Science, Haryana, Karnal bagged the first prize in scientific hobbies

Symposium on Tropical Ecology

(14-21 January 1971)

THE International Society for Tropical Ecology, the International Association of Ecology and the Indian National Science Academy, jointly organized an international symposium, which was inaugurated by Professor B R Seshachar, President, Indian National Science Academy, on 14 January 1971 in the Academy's auditorium. About 50 foreign and Indian scientists attended the symposium and discussed various implications and evaluations of organic production in the tropical world. Professor Frank B. Golley (U.S.A.), and Professor R Mishra (India) were the conveners of the symposium

Wise management of resources and environment is very much dependent upon our understanding of the rate of production of plants and animals. The emphasis on the tropical world in this symposium assumes greater significance when we consider the diversity of flora and fauna, the richness of biological wealth on the one hand and the magnitude of population problems in the region on the other hand. It is hoped that information and ideas that would be pooled together will generate further imagination and wisdom towards survival and better life of man against accelerating technology.

India is busy fighting poverty and hunger brought about by the rising growth of population and maladjustment of cultural values. The deep-rooted traditions, saintly

living and involvement in nature conservation are fast yielding place to increasing wants, strained economy and surveillance of human spirit which usually go with the technological revolution Like the West India is also worried about the deteriorating conditions of environment and biological wealth. Purely technological solutions lead to a chain of new problems, in the long range. Solutions have to be sought out only after a careful examination of all the aspects of interlinking forces of environment and organisms

The symposium opened introductory papers on organic productivity and environmental control. It was followed by papers on the evaluation of production in plants and animals in a variety of natural systems like grasslands, forests and freshwaters. Several research papers also emphasised crop ecosystems.

A special session presided over by Shri Pitamber Pant, Member (Prospective), Planning Commission, was devoted to discussion on role of ecologists in the economic development of India.

Along with the symposium, the Indian Regional Committee of the Education Commission of the International Union of Conservation of Nature and Natural Resources was inaugurated on the same day. The Committee discussed and drew plans for introducing the concept of conservation in education at various levels in the country.

Books for Your Science Library

Physics: Part I and Part II

Robert Resnick and David Halliday

Wiley Eastern (Pvt) Ltd., New Delhi,
1970 (Reprint), Price Rs. 13 50 each.

OUR country needs a revolution in physics teaching, a revolution regarding both the content and the approach. What is called "the explosion of scientific knowledge" is pouring in an ocean of facts on an unprecedented scale to be encompassed in our scheme of teaching. Teaching needs tuning and pruning to suit the needs of the times and the needs of the people. So it is obvious we have to look for new approaches and new methods Of the various undergraduate textbooks in physics that have come in the field to cope up with this challenge, *Physics* by R Resnick and D. Halliday outweighs many in quality. This book is especially suitable as a textbook in the first two years of the Physical Science and Engineering degree courses.

In giving an integrated approach to the various concepts in physics and also to bring out the interrelations and interdependence of the various disciplines, Feynman lectures have reached, perhaps, the most spectacular success. But I do have my reservations in using Feynman as a textbook especially in a country like India I rank Resnick and Halliday as the next best book in physics doing ample justice to the above-mentioned aspect. It has taken special care to eliminate what we call 'the dead weight' in our conventional physics courses Wherever there is an opportunity the authors are particularly careful to choose situations from modern topics for problems illustrating principles and concepts dealt here This gives a chance for the students right from the early stages to have occasional glimpses of the advanced topics As a teacher I have seen the students feel delighted to have such examples. This makes them more equipped with the terms and methods of higher realms where they will have to dwell more deeply in future The 'Examples' in this book deserves special mention. They are short questions excellently designed to test the understanding in the subject.

The supplementary topics give some important portions dealt in a greater depth, perhaps meant for those who are bit ahead of the common lot The diagrams and illustrations are very good from the instructional point of view and they are attractive as well Use of vectors and calculus from the very beginning is something which the Indian universities are to welcome with grace Mathematics and Physics are to go hand in hand for steps higher, if we mean business.

Perhaps Mechanics and Electromagnetics occupy the pride of place in this book But topics especially Polarisation and Diffraction are not up to that satisfaction. Chapters on Quantum Nature and Wave Nature of particles are well designed for a beginner

Though it is essentially a textbook meant for the degree classes, it presents a correct perspective of physics for all physics teachers. Where we are to stress and where we are not to stress are clearly brought out. It is an excellent source book for the teachers of the high school classes Every school can go in for a few copies of this cheap edition and it will serve very useful for the modernisation of physics teaching

T.N.R.K. KURUP

The Psychology of Learning and Instruction: Educational Psychology

John P Dececco

Prentice Hall of India Private Ltd, New Delhi, 1970, pp 800, Price Rs. 18.00.

THIS book, written in a lucid style which, as happens all too often, does not lead to any loss in scholarship, was first published in 1968. It is indeed a welcome addition to the Eastern Economy Editions.

The book, addressed to the student teacher, was in its original edition part of an instructional package which included an *Instructor's Manual* and a *Student Guide*. The Eastern Economy Edition seems to have dropped the two adjuncts But, with its careful organisation of the text, systematic interrelating of topics, lists of instructional objectives for each chapter, and embedded questions with accompanying answers and explanations, the book in itself makes a complete instrument of instruction. Each part of the book (of which it has five in all) and each chapter under the five parts, starts with an introduction The introduction orients the student to the content of the part or the chapter. The chapter introduction is followed by a list of instructional objectives which tell the student in advance what he should be able to do upon completing the chapter. At the end of each section under the chapter, he is asked to return to this list of objectives for checking up his performance against the objectives. Here also is an embedded question, usually in multiple-choice form, which helps him to assess his achievement An answer section at the end of the book gives the correct answer to the question and its defense. Finally, each chapter concludes with a summary and a list of suggested readings. The summary recapitulates the major points of the chapter and enables the student to review important conceptual relationships. The suggested readings are annotated and they include both elementary and advanced treatments of the topics so that further study in the area can be purposefully directed. It is not in many textbooks that we come across an organisation of learning material that is equally conducive to self-learning Not many in this country, anyway.

The teaching model adopted, with modifications as the basis of the book, is the one propounded by Robert Glaser in 1962. The first chapter offers a competent though brief discussion of the model and compares it with some other models of teaching dealt with equally competently. These other models are: the Computer-based model, the John Carroll model, the Interaction model, the Socratic model and the Jesuit or Classical Humanist model (By the way, DeCecco calls, the last two historical models

as distinct from the first three which he designates as 'psychological models'. One does not exactly see why, for, even the so-called historical models can be easily seen to have a psychological basis)

The broad division of the book correspond to the four components of the model—instructional objectives, entering behaviour, instructional procedures and performance assessment—and the discussions under them centre around these components

The explicit acceptance of Glaser's model as the basic model saves the book from the criticism that one school of psychology of learning and instruction is projected as the whole of it, even as the Hormic school of psychology used to be projected as the whole of psychology in our teacher's college, till quite recently.

There are indeed no pretensions here. But, we should not forget that in the field of educational psychology no consensual validity has been achieved so far and conflicting theories of teaching and learning do exist. Many teacher educators might, therefore, feel that it was rather unfair not to give the student a chance to get familiar with at least the most important of these theories so that he could choose from among them and utilise the ones that met his purposes This is another way of saying that the stage of development of a discipline must find reflection in a textbook meant to introduce the beginner into the field. This may at times prove confusing to the beginner but the alternative perhaps may have a more dangerous outcome, a one-sided and possibly distorted perspective on the field. But, this apart, it really looks odd that a book on educational psychology ignores for instance the Field Theories or Personality.

This is not to detract from the usefulness or the other merits of the book. Good books on educational psychology are rather hard to come by for Indian students because of their high cost Here is an excellent introduction to the field, more particularly to the S-R school of it, at a price within the the reach of most students. Even advanced students will find the book useful with its thirty and odd pages of bibliography at the end and the annotated list of readings that follows each chapter Readers of this journal may find the chapter on the new science and mathematics, problem solving, and educational technology of particular interest.

M. Abu Baker

Strategies in Science Education
A.N. Bose, J. K. Sood and N. Vaidya (Eds.)
Regional College of Education, Ajmer.

This is a book primarily designed for science teachers in schools. It can legitimately be called the finished product of the two Method Masters' Institutes at Bhubaneswar in 1968 and at Ajmer in 1969. The foreword of the book is written by an eminent science teacher educator Willard J. Jacobson of the Columbia University, U.S.A.

Science education is a field where a good deal of serious thinking coupled with concerted efforts and action in a big way is urgently needed in our country. It is true that the number of original work in India reflecting this need of the day is rather very discouraging. So I feel the editors and publishers of this book deserve special appreciation for their laudable efforts to bring forth this issue.

The book is divided into three parts: 1. Science Education, Basic Considerations, 2. Trends in Science Education and 3. Science in the Classroom. In all there

are 15 essays with two sets of appendices. Three essays by Mr. Jacobson are the best among them. The essays of Mr. Vaidya are rather prosaic in presentation. Lucidity in explanation preferably with examples rather than play with technical terms would have helped our teachers. Essays on Nuffield Project, U.S.S.R. System, Science Teaching in India, etc , appear to be lacking in depth and gravity. Giving a long list and that too defying distinction and clarity in most cases need not necessarily be impressive. The most glaring aspect while I was going through this book was the innumerable mistakes, both in spelling and in construction! The language is also poor.

But it gives a good deal of information needed by our science teachers. It is a good start in the right direction. I personally feel it can be a useful addition to our school libraries.

T.N R K. KURUP

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I, S.A Abidin, hereby declare that the particulars given above are true to the best of my knowledge and belief.

S.A Abidin
Publisher

Problems in Mathematics

J N. Kapur
Department of Mathematics
Meerut University
R.C. Sharma
Department of Science Education
NCERT

SS56: (i) In a box there is a number of balls of c different colours. What is the smallest number of balls for which we can say that, however the colours are distributed, there is at least one set of s balls of the same colour? Justify your statement.

(ii) Further, if $n>c$, what is the smallest number of balls for which we can say that there are at least n sets, each set containing s balls of the one colour? (In forming these sets we do not require that sets be of different colours, e.g., from $2s$ balls coloured red we could form 2 sets.)

SS57: (a) Prove that if n is a positive integer greater than 2, the numbers 2^n+1 and 2^n-1 are not both prime.

(b) Prove that of the three positive integers a, $8a-1$ and $8a+1$ there is at least one which is not prime.

SS58: All the odd integers, beginning with 1, are written successively (that is 1 3 5 7 9 11 13 15 17 19 21 ... .).
Which *digit* occupies the 100,000th place?

SS59: (i) If S_r denotes the sum of the rth powers of the numbers 1,2,3, . 9, show by considering the sign of
$(1+x)^2+(2+4x)^2+(3+9x)^2+ \dots +(9+81x)^2$ that $S_3^2<S_2S_4$.
Give an outline proof also of the following:

(ii) $S_2^2<9\ S_4$;

(iii) $S_{m+n}^2<S_{2m}\ S_{2n}$, if $n\neq m$.

(iv) State and justify—in a few lines of discussion—more general results applicable to sets of numbers other than 1, 2, . 9.

SS60: Consider all points in the co-ordinate plane XOY whose co-ordinates are both positive integers The sum $x+y$ of the co-ordinates of such a point is called the index of the point. I write down the point (1,1) of index 2, then the points (1,2) (2,1) of index 3 in ascending order of their first co-ordinates; then the points (1,3), (2,2), (3,1) of index 4 in ascending order of their first co-ordinates; and so on The result is: (1,1), (1,2), (2,1), (1,3), (2,2), (3,1), (1,4), (2,3), (3,2), (4,1), (1,5), ...

If (x,y) is the nth point written down, find a formula for n in terms of x and y.

Solutions to Problems in Mathematics

SS 46: A die consists of a cube which has a different colour on each of its 6 faces.

(i) How many distinguishably

different kinds of dice can be made?

(ii) How many different ways are there to make a pair of dice?

Solution

(i) Choose a specific colour, say A, and use it for the upper surface of the die. Choose any colour B for the lower surface. There are five choices for B. The cube may now be rotated so that same colour C is facing us. Now the remaining sides are fixed with respect to these three. We can distribute the three remaining colours over these remaining three sides in $\underline{\lvert 3} = 6$ ways. Therefore there are a total of 30 possibilities. We can also obtain the result by considering the rotation symmetries of the die. If there were no rotation degeneracies, we would have $\underline{\lvert 6}$ possibilities. However there are six sides that can be chosen facing up and once such a choice is made, any one of the four sides may be taken as facing forward. This exhausts all degeneracies and gives $\underline{\lvert 6}/(6\text{x}4) = 30$ ways. In general, for a figure with N faces and painted with N different colours, the number of possibilities is $\underline{\lvert N}/R$, where R is the number of discrete rotations which leave the figure invariant.

(ii) Here one must take account of the fact that the individual dice are indistinguishable. Thus if each die may be coloured in N different ways, the number of distinguishable pairs of dice is $N\ (N+1)/2$. In our case $N=30$ and so the answer is $(30 \text{ x } 31)/2 = 465$.

SS 47: Each face of a regular octahedron is to be given a different colour. If eight different colours are available, how many distinguishable octahedra can be made?

Solution

The regular octahedron can be treated in the same way as the die in SS 46.

The symmetry viewpoint is particularly useful. If we take one of the six corners pointing up, we get 6 possibilities; there is still a four-fold rotational degeneracy giving 24 possibilities. Alternatively, if one of the eight sides is fixed in space, the octahedron will still entertain a three-fold rotational degeneracy. Either way there are 4 degenerate positions. We obtain therefore $\underline{\lvert 8}/24 = \underline{\lvert 7}/3$ possibilities.

Another way of counting requires more care. We draw the octahedron flattened;

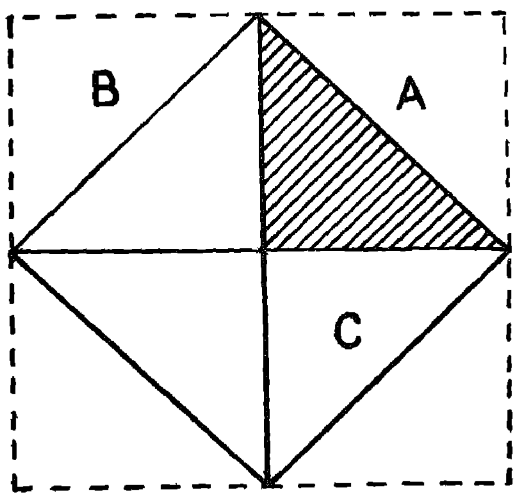


Fig 1

the dashed lines join when the figure is folded into 3 dimensions. Colour any surface with some colour (shaded in the figure) and face that side up. Now colour all surfaces but A, B, C. Because all other surfaces are uniquely specified with reference to these, the number of possibilities is 7.6.5.4 These are now only two independent choices for A, B, C. For if a given colour is chosen for any of these, a rotation will bring these surfaces into one another. Thus, the first of the three to be filled gives no extra possibilities, while the remaining two leave 2 possibilities So the answer is $7.6.5.4.2 = \underline{|7}/3$ as before

SS 48: A pentomino is a figure made of five squares placed so that each square has a side common with some other square. Two pentominoes are congruent if one can be placed on the other so as to coincide with it How many different (non-congruent) pentominoes are there?

Solution

There are twelve such petominoes (*See Fig 2.*)

SS 49: Enumerate all non-congruent hexominoes Shade consecutive squares in different shades and find how many of them contain equal number of different shaded squares and how many contain an unequal number?

Solution

It is easily seen that 24 of these are odd hexominoes and contain 3 shaded squares and 11 of these are even hexominoes in which the number of shaded squares is 2 or 4. (*See Fig. 3*)

SS 50: Obtain all possible solid polyminoes made from 4 cubes in such a

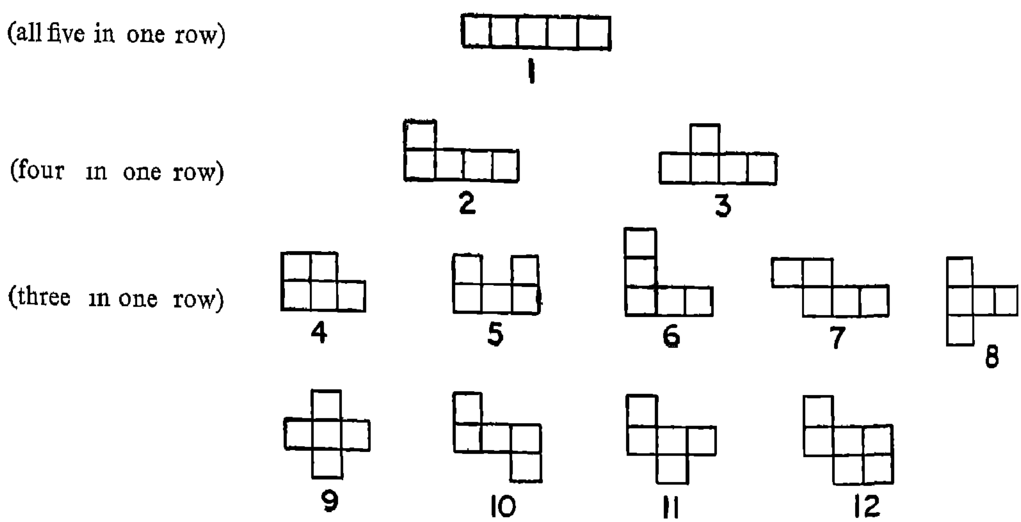


Fig. 2

way that each cube touches one another along a face. How many solid pentominoes can be made?

Solution

There are seven such which are shown in Fig. 4 on page 90.

The total number of solid pentominoes is 29

SS 51: Draw all possible pseudotetrominoes, i.e., figures formed of four squares each of each touches some other along an edge or at a vertex. (*See Fig 5 on page 90*)

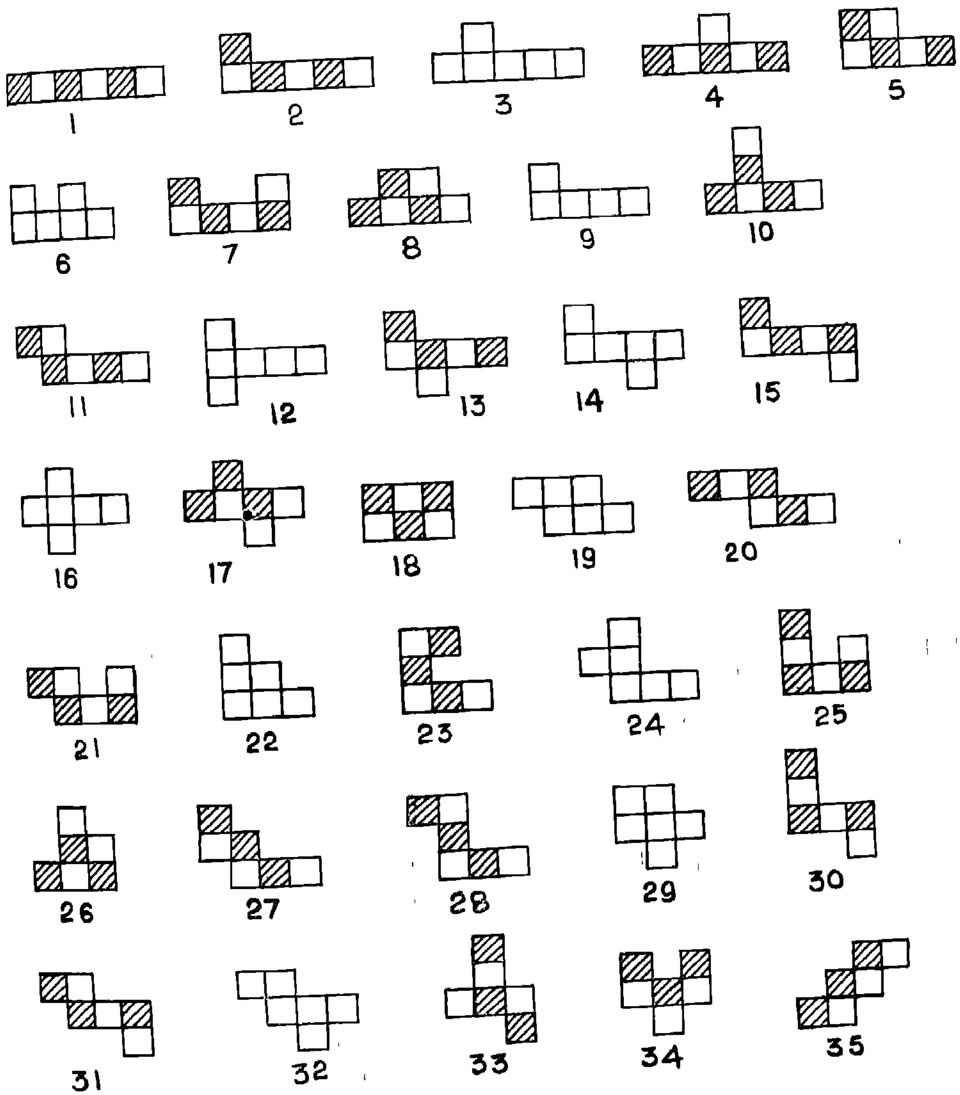


Fig. 3.

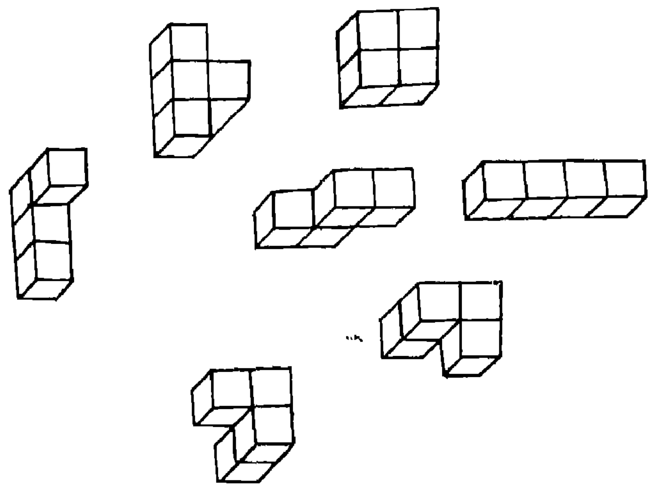


Fig. 4

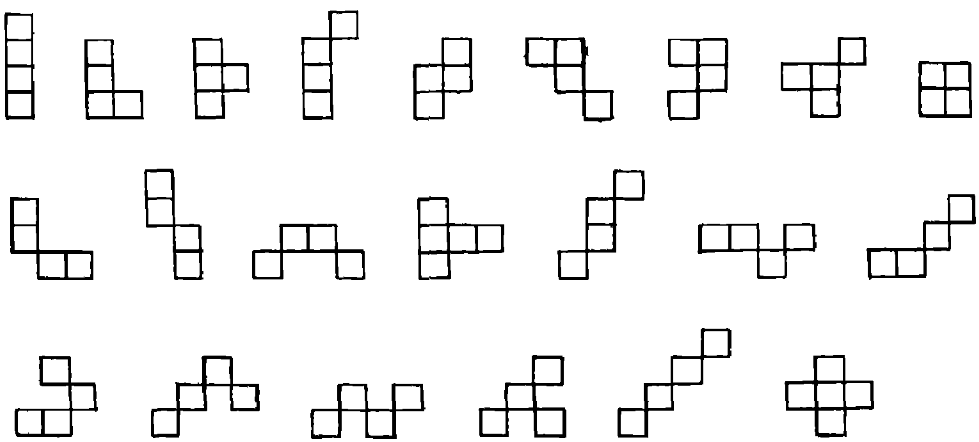


Fig. 5

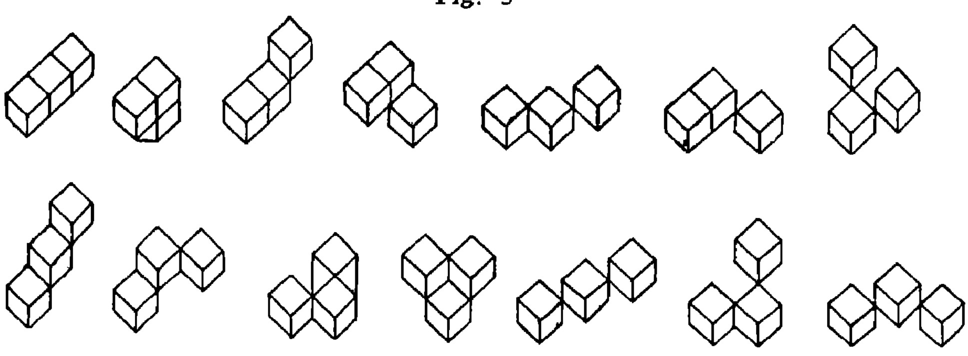


Fig. 6

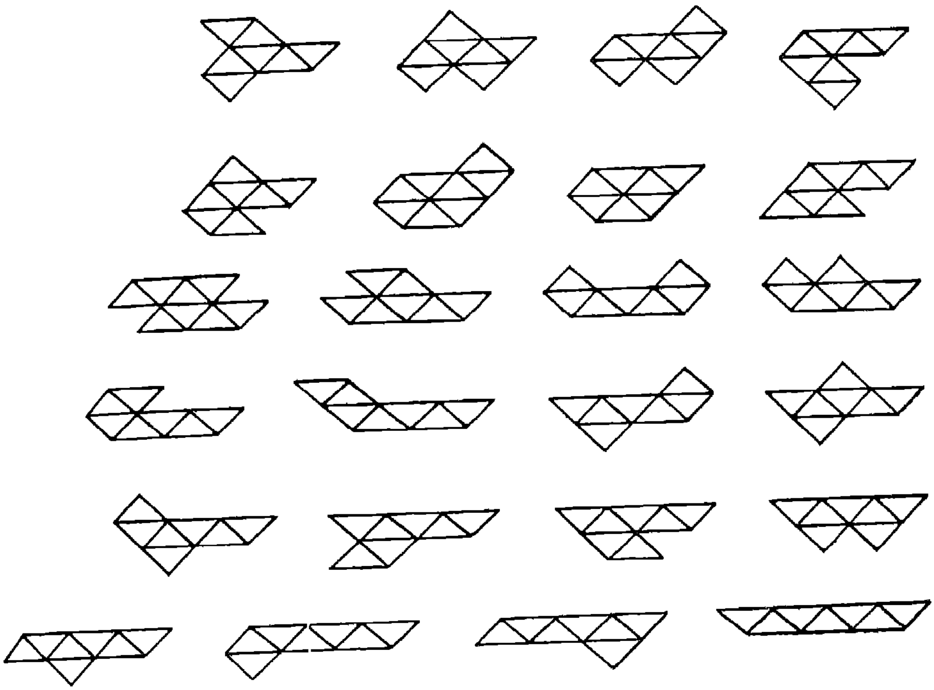


Fig. 7

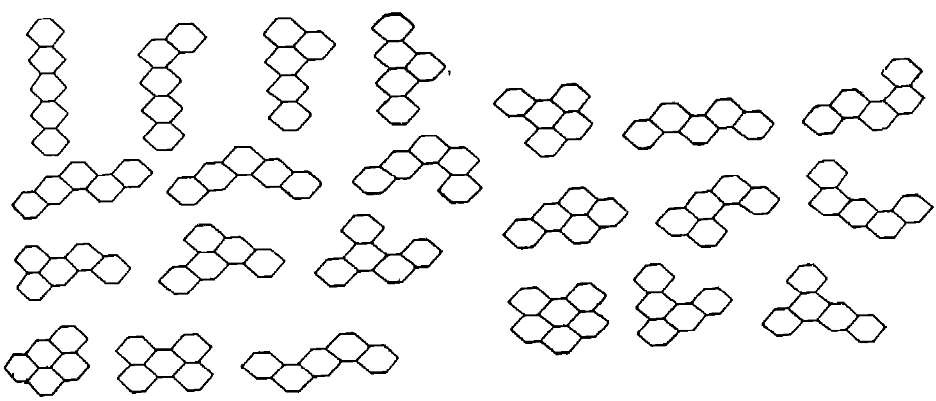


Fig. 8

SS 52: Draw all possible solid pseudotrimones, i.e., figures formed of three cubes, each of which touches some other along a face or an edge or at a vertex. (*See Fig 6*)

SS 53: Draw all possible heptiamonds, i.e., figures formed of seven equilateral triangles each of which touches some other along an edge. (*See Fig 7*)

SS54 : Draw all possible figures formed of

five regular hexagons each touching some other along an edge. (*See Fig 8 on page 91*)

SS 55: (i) Arrange 12 pentominoes into two 5 x 6 rectangles of 6 pentominoes each.

(ii) Arrange the 12 pentominoes in an 8 x 8 square pattern with a 4-square hole in the middle so that the pieces separate into 2 congruent parts, each using 6 of the pentominoes.

(iii) Divide the 12 pentominoes into 3 groups of 4 each. Find one 20-square region that each of the three groups will cover.

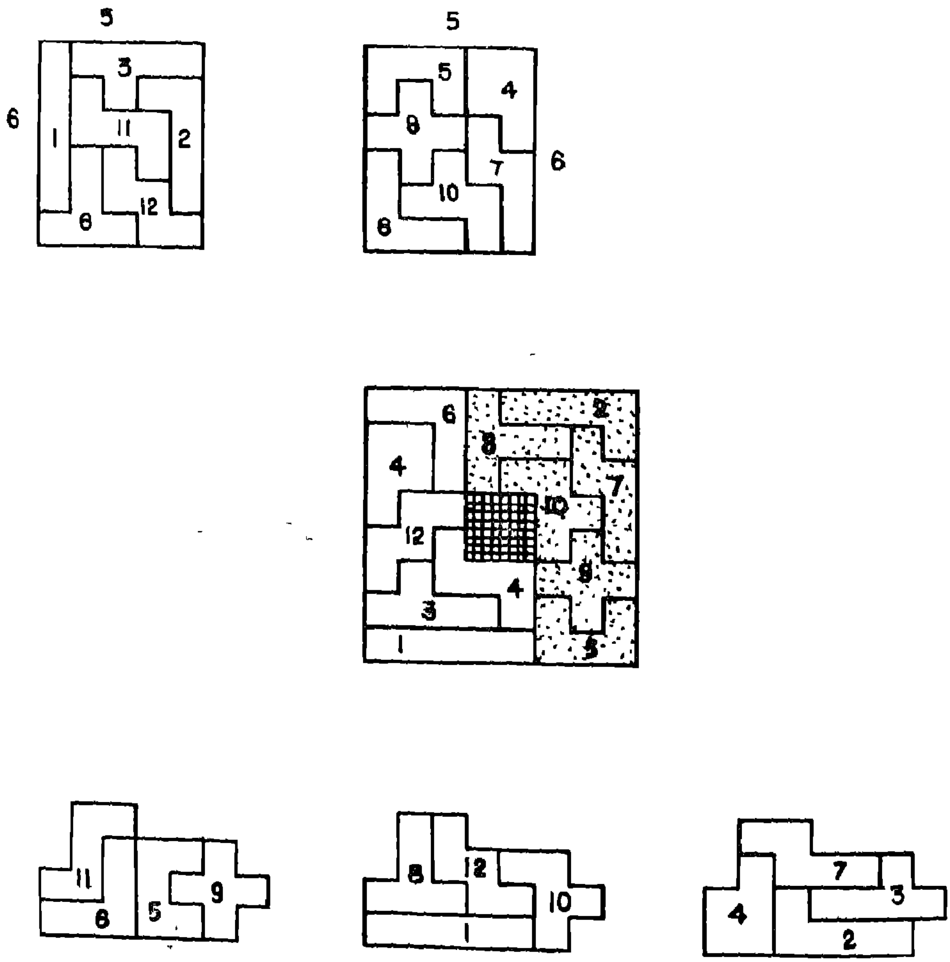


Fig. 9

Unesco Asian Seminar and ICC General Assembly in New Delhi

(December 1970)

TWO important international gatherings were held in New Delhi in December 1970. The Government of India played host to both these meets, and Dr. M.C. Pant on behalf of the NCERT was the Liaison Officer.

1. *Unesco Regional Asian Seminar for Leaders of Youth Science Activities* (14 *to* 18 *December* 1970)

The theme of this seminar was "contribution of out-of-School Science Education to Development". The Seminar was held under the auspices of Unesco and the ICC with headquarters at Brussels, Belgium. Sixteen delegates from 11 countries of Asia attended this meeting.

Dr G.A. Teterin on behalf of the Unesco, Mr. Francis Wattier on behalf of ICC and Prof A.M. Ghose on behalf of IAESA of India attended the meeting besides the delegates. The Seminar was inaugurated by Sri S. Chakravarti, Secretary, Ministry of Education.

Four themes were discussed:

1. The place and role of out-of-school science education within the context of problems and needs of developing countries in Asia.
2. Methods of out-of-school science education for urban youth.
3. Methods of out-of-school science education for rural youth.
4. The problems of regional and international cooperation.

The problems and questions discussed concerned the science clubs, the science competitions and exhibitions, camps and excursions on out-of-school youth activities, the role of the press, radio, television, films, museums, public lectures on "Scientific information for the Youth". Several delegates presented papers a few of which are reproduced in this issue of *School Science*.

2. *International Coordinating Committee for the presentation of Science and the Development of out-of-school Scientific Activities*
(ICC General Assembly, New Delhi 18 *to* 22 *December* 1970)

This important Assembly was held immediately following the Unesco Asian Seminar in order to enable all the delegates of the latter to participate. Thirty delegates from 23 countries participated in this Assembly

These countries were: Argentina, Belgium, Brazil, Cambodia, Canada, Ceylon, Egypt, France, W. Germany, Hungary, India, Indonesia, Israel, Italy, Japan, Korea, Malaysia, Netherland, Philippines, Sweden, Tunisia, Thailand and USSR.

Besides the delegates, there were several observers The International Union for Conservation of Nature and Natural Resources was represented by Shri S. Doraiswami and Dr. V.M. Galushin, both members of the permanent IUCN Commission on Education. Dr. G.A. Teterin represented the Unesco. Mr. Francis Wattier, Secretary of the ICC conducted the proceedings. Prof V K.R.V. Rao, the then Minister for Education, inaugurated the Assembly on 18 December and Prof. Ghose of the Indian Association for Extra Curricular Science Activities presided over the working sessions.

After fruitful discussions during the four sessions the following recommendations were made:

1. To set up an information service to provide members with the most up-to-date data on extra curricular activities.
2. To organize International Science Fair periodically by the ICC.
3. To organize training seminars for out-of-school science programmes by ICC.
4. Grant subsidies to promote students and teachers to attend out-of-school programmes, conferences in other countries.

ICC AND THE IUCN-II

IN his letter of 12 November 1970, Dr. G. Budowski, Director-General, IUCN, appointed us to represent the IUCN at the ICC General Assembly held in New Delhi from 18—21 January 1970. Accepting this nomination we both participated in the sessions of the General Assembly. Mr. F. Wattier, Secretary-General, ICC, advised us also to participate in the Unesco Asian Regional Seminar for leaders of Youth Science Movement held earlier from 14—18 December 1970 Mr. S. Doraiswami took part in this Seminar

The programmes of the Assembly and the Seminar included some items which gave us opportunities to establish good contacts and cooperation between the ICC and the IUCN Of particular importance in this respect were Item 10, "Possibilities of Cooperation with other international organisations" and Item 11, "Calender of international youth science activities in 1971" of the agenda of the ICC Assembly as well as Items 1, 2 and 4 of the agenda of the Seminar.

The IUCN policy for cooperation with ICC was stated and a brief idea of efforts of the IUCN Commission on Education in a field of out-of-school science activity was presented.

Mr. S. Doraiswami gave publicity to the proposed Indian Regional Committee of the IUCN Commission on Education and explained properly its aims and programme. His contributive paper, "Scope for cooperation between the IUCN and the ICC with regard to the contribution of out-of-school science education to development" (published else where) drew the attention of and created interest in the delegates. It generated active discussion and exchange of views on the matter. All the delegates fully appreciated the idea of conversion of the Indian Committee into the South Asian Regional Committee. They expressed their wish to inform the authorities concerned in their countries and do their best to convince them to join the Regional Committee later on.

Dr V.M. Galushin stressed the urgent need for using all channels, including out-of-school science activity to stimulate interest and create an awareness of our environment among the young generation His information about the joint IUCN-IYF Project "International youth conference on the future environment" (Project No 1-3) received an active response from the delegates and ob-

servers He also suggested the starting of joint IUCN-ICC project No 33-13, "Annotated list of popular scientific periodicals for children and youth" recommended by Dr. J Cerovsky He proposed one more joint IUCN-ICC Project, viz, "Preparation of a complete list of youth organisations which are or will be dealing with conservation of nature", and the starting of a scheme for permanent exchange of information on conferences, symposia, youth camps and other activities both of youth and environmental organisations between Unesco, IUCN and ICC. Mr F Wattier, Secretary-General, ICC, and the delegates agreed to participate in these projects

At the closing session of the ICC General Assembly, Mr. S. Doraiswami proposed a draft resolution "Cooperation with IUCN" which was unanimously adopted by the delegates The necessity for linking out-of-school activity with solutions to environmental problems was also stressed by Mr. S Doraiswami in the resolution moved at the Asian Seminar.

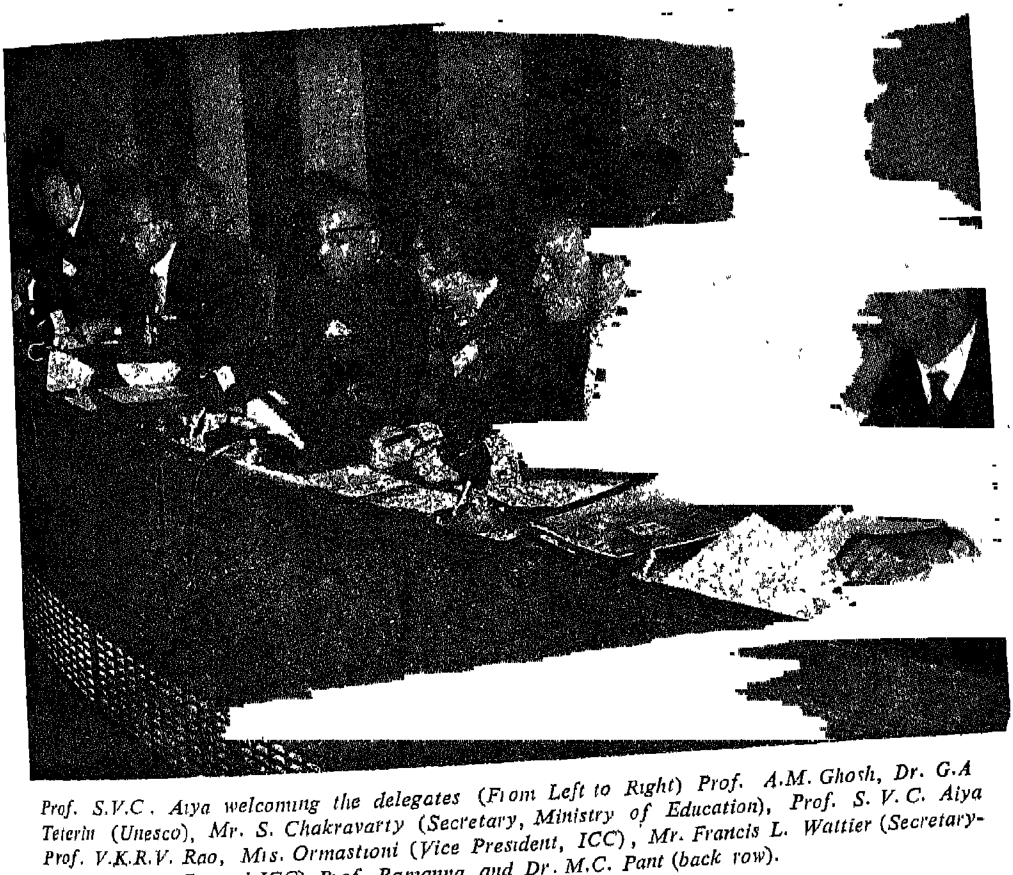
One of the most useful results of IUCN participation in the Assembly and the seminar was the good personal contracts established with representatives of Youth Organisations from 23 countries including 10 Asian ones. Some of them are dealing or can deal with environmental education They are Mr. M. Atputhanathan (Ceylon), Mrs S L. Antiola (Philippines), Mr. S. Tsuruta (Japan), Mr. M P. Prabhakar (Malaysia), Dr. A.M Ghose (India), Mr. P. Sankhala (India), Mr. A. Shadmon (Israel), Mr Salah Galal (UAR), Mr G. Ekegard (Sweden), Mr. N S Helm (Canada), Dr W.P.J. Lignac (Netherlands), Mr. A. Canino (Italy) and others. We believe that maintaining of constant communications with them will be useful for the Indian Committee and the IUCN Commission on Education.

We wish to record our appreciation for the understanding of environmental problems and willingness to cooperate, shown by Mr Francis Wattier, Secretary-General, ICC, and Dr. Genrih A. Teterin, Unesco Representative who contributed so much for the success of the ICC General Assembly and the Unesco Asian Seminar.

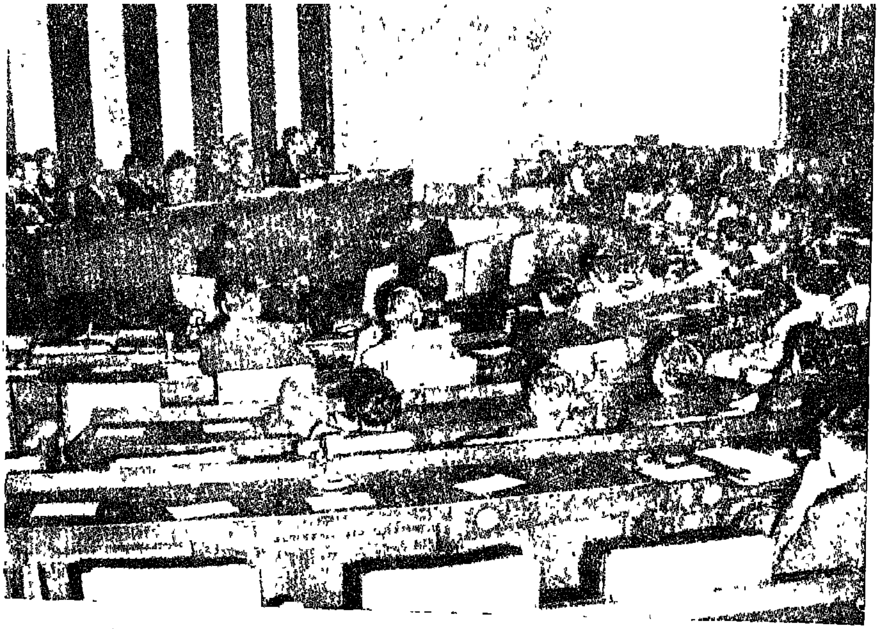
In conclusion we would like to express our deep gratitude to Dr G. Budowsky, Director-General, IUCN, and Dr J. Cerovsky, Education Executive Officer, IUCN, for nominating us as IUCN representatives We would be happy if our participation at the ICC General Assembly and the Unesco Asian Seminar has resulted in some contribution to the IUCN activity.

Report by the IUCN Representatives Mr S. Doraiswami and Dr. V M. Galushin at the ICC General Assembly, New Delhi (18-21 December 1970) and at the Unesco Asian Regional Seminar for Leaders of Youth Science Movements (New Delhi, 14-18 December 1970)

ICC GENERAL ASSEMBLY INAUGURAL FUNCTION ON 18 DECEMBER 1970



Prof. S.V.C. Aiya welcoming the delegates (From Left to Right) Prof. A.M. Ghosh, Dr. G.A Teterin (Unesco), Mr. S. Chakravarty (Secretary, Ministry of Education), Prof. S. V. C. Aiya Prof. V.K.R.V. Rao, Mrs. Ormastioni (Vice President, ICC), Mr. Francis L. Wattier (Secretary-General ICC) Prof Ramanna, and Dr. M.C. Pant (back row).



A view of delegates attending the General Assembly of ICC

Prof V.K.R.V Rao chatting with the delegates

Prof. V.K.R.V. Rao, the then Minister of Education, talking with Mrs. Ormostiom of Brazil and Vice-President of ICC.

ICC General Assembly

Inaugural Address (18 December 1970)

PROF. V.K.R.V. RAO

MADAM Vice-President, Ladies and Gentlemen:

It gives me great pleasure, not only in my capacity as Minister for Education and Youth Services in the Government of India but also in my personal capacity as one who has spent most of his life in the educational world, to welcome you, Madam Vice-President, and all the delegates from the several countries of the world who are assembled here The Government of India deems it a privilege to host your organisation for its deliberations which we consider to be as much of value to our own country as to all others. Yours is a non-governmental organisation which is supported by the Unesco. The fact that more than 70 countries of the world are members of your organisation, speaks for the valuable work that you are doing Out - of - School scientific activities represent, to my mind, the most important means of encouraging creativity and stepping the tempo of scientific work among the younger generation in any country in the world Your organisation is concerned with this important work and therefore, the results of your deliberations would be of value to all of us I am sorry, Mr. R A Stevens of the British Association for Advancement of Science, who is the President of your Assembly, is not able to come here owing to personal problems But you have heard Prof Aiya reading us the text of his letter and I should like to say how much impressed and moved I was by the tone and the content of the letter that Mr Stevens addressed to Prof. Aiya on this occasion. While we all miss him very much in our midst, I sincerely hope that all of you would address yourself to the task set before you with the same zest and enthusiasm you would have shown had Mr Stevens also been present. I am sure, you will do it because we have Madam from Brazil to give you the inspiration and stimulation which you might have got from Mr. Stevens.

There is a tendency in all countries of the world to streamline procedures for instruction and evaluation in the teaching-learning process Consequently, some of the school science teaching is tending to take on a routine character This is perhaps inevitable because every country in the world is required to teach more and more of science and that too to larger and larger numbers. A natural consequence of this development is the sad fact that creativity tends to get destroyed and the required zest and enthusiasm for doing things on one's own in the field of science does not get developed among our school students The result is that we are failing to nurse the very qualities for which we give scientific education to our

children. As you are all aware, the instruction and the opportunities given at the school stage are responsible for shaping the child when it grows and becomes an adult It follows necessarily, therefore, that we must explore other avenue for nursing creativity and zest for science among our school children. Here is where the importance of out-of-school scientific activities comes in.

Out-of-school scientific activities are necessary for all school children and not only for those who are looking forward to a scientific or a technological career I want to emphasise that at the school stage this out-of-school science activity should not be confined only to those who are going to become specialist in science later on These opportunities should be available to all children who are in school We are living in a technological age and whatever the vocation we care to choose, we cannot escape the use of technology. I feel some time sorry that, that is so but there is no escape from the fact Thus even if one is an administrator with a degree in history or literature or economics like myself, he may be required to drive his car and rectify minor defects when it stops on the road. When there is something wrong with his Radio or TV or a hot plate or a bed lamp, he cannot always think in terms of calling an expert He has to do some of these jobs himself What is more, he has to get used to modern gadget and learn to live with them He cannot possibly do this unless he has played with science using his hands and done some jobs while he was young I can say this with perfect sincerity because I am personally incapable of doing any of these jobs myself like either repairing a TV set or a bed lamp or defects in a car or any other thing. I am personally incapable of doing any of these jobs for myself mainly because I did not have the chances to go in for any out-of-school scientific activities when I was at school many decades back I do not want the thing to happen to the younger generation and hence my enthusiastic advocacy of out-of-school scientific activities for the school children of today's India.

There is a third and more important reason for encouraging out-of-school scientific activities By doing jobs, we learn that we cannot succeed in every thing. We develop the habit of taking our failures more philosophically. Further, when we make things ourselves and also make them work, we develop not only self-confidence but also the habit of scientific logic and will not get carried away by superstitions, obscurantist beliefs and the like There is not much time to adjust onself to modern and scientific way of life It is very important for a country like mine which is emerging suddenly from what we call the medieval state of life. There is not much time to adjust onself to modern and scientific way of life. Thus, the development of a scientific temper and rational way of thinking flow automatically from out-of-school activities, where we choose the job we want to do and do it the way we like it. The last two conditions are extremely important i e., the choice of the job by the person who is going to do and not only the choice of the job but choice also the way in which he wants to do the job If we ignore these conditions in our desire to streamline out-of-school science, then we will destroy the very objectives which have forced us to think in term of out-of-school science And if you do that, I think, the ICC can appropriately take on the title of the grandmother. I think it is very important to avoid stream-lining and routinizing out-of-school science activities. It is bad enough you have got to do it when it comes to formal activities If you also want to bring all these informed activities under a straight

jacket, then we will be failing in the very purpose which we have in mind when we want to start with these activities. Mr. Stevens, your President, has already written a book on out-of-school scientific activities for young people which has been published by the Unesco. It describes science clubs, science fairs, camps, meetings, museums, nature conservation, etc In fact, I should like to suggest to Unesco representatives, I think who is present here, that in pursuance of a resolution which has been adopted by the General Assembly of Unesco in Paris at the instance of the Indian delegation, when I suggested that some of the Unesco aid should be made available for translation of books into Hindi so that a much larger of people will be able to get acquainted with the valuable material that has been published by the Unesco, that one can make a very small beginning by taking this book for translation because this is a book which will help a large number of people to get acquainted with what you call the different methods of organising out-of-school activities. Not that we do not knew about them, we are doing these things. But the advantage is that in this book it is all in one place, by a person who has great deal of experience in this matter and the very fact that Unesco has brought about this, and that it is a satisfactory compilation and satisfactory introduction for the out-of-school scientific activities. If the Unesco helps the National Commission to bring it out in Hindi, then I might try to persuade my own other organisations in this country also to bring it out in other Indian languages so that all the students of India and the school children in India will be able to get a kind of preliminary introduction to out-of-school science activities as they may be organised and described by somebody who is a pioneer in this field. Many of these activities have been developed in one way or the other in many of your countries including my country, although the degree of development may vary from country to country I hope I am not offending anybody, I am trying to estimate the age-group, I am addressing. However, I have an impression that all such activities have been initiated through senior and elderly people. If this is so, it is unfortunate. Perhaps, a live discussion with young school students may have contributed some more exciting types of activities and I can tell you this not merely academically but having seen a number of science fairs and exhibitions in my own country which have been organised by school students and not by college students, not university students but who belong to 8th, 10th and 11th class and the kind of exciting things that they are trying to produce. Some of them may be completely unpractical. That is a different matter but the excitement and the zest they have brought in, imagination they have brought in, to use their knowledge of science, to create things is something which I think is very precious and the moment a person with great deal of reasoning and sobriety, as we are supposed to possess interferes, I am afraid, the kind of imagination and recklessness which is so much important in terms of excitement and adventures tends to disappear and therefore, I think myself it is a good thing to get a few young people involved in discussing out-of-school science activities. Keeping this aspect in view, we have invited to this Conference, from our own country, a selected band of bright young students to attend parts of your discussions We are also associating some selected teachers in this work. After seeing whatever you do, they can draw inspiration and chart out new paths that are still unknown. We have also in our midst representatives of science museums and Education Depart-

meets of States where there is significant scientific activity. I have no doubt that all of them will benefit from your deliberations and from your advice on problems of interest to them on which they might put questions to you, when they meet you more informally. I may add that the science exhibition which accompanies the programme for your assembly will add zest and interest to all our students because they will get an opportunity not only of showing what they have done but also of talking to many of you. You will thus be contributing significantly to the growth of science in my own country I know that this contribution may not be measurable in terms of money, but I have no doubt about its adding a valuable psychic income to my country.

I gather that during this assembly at Delhi, you will focus attention on the following items.

1. Services to be rendered by the ICC to its member Associations,
2. Participation in the programme of Unesco, of the Council of Europe, and of other international organisations;
3. Participation of youth in the planning and implementation of youth science activities, the programme which I thought should be given a great deal of importance;
4. Extension of financing of exchanges,
5. Programmes of assistance to developing countries in which I am also not disinterested; and
6. Long-term programme.

All these items can be of considerable interest to all of us I may say a few words about each of these items. The first service that the ICC could think of rendering to its member-associations would be through a suggestion that the member-associations including our own Indian Association should increasingly associate students and teachers with their organisations and executive bodies. That way, I think, lies a glorious future. Regarding the second point, I should state that more participation in the programmes of Unesco, etc, would not be adequate. We will have to think in terms of these organisations coming to the aid of the ICC both financially and through the supply of expert advice Proper schemes carefully worked out for such purposes can prove very helpful. Referring to the third point, I have already stressed the importance of youth being brought into the picture of the organisation, but I may add that one should not go beyond getting down to a broad frame-work in any process of planning youth science activities Any detailed planning even by the youth themselves will destroy initiative and enterprise on the part of its individual members. You will see that though I have been a planner myself, I spent 3½ years as a Member of the Indian Planning Commission and I have been normally known as a great advocate of planning for economic purposes, I am also very much aware of the inhibitory effect that planning can have on initiative and enterprise and therefore, in the planning of youth science activities, whatever is planned, should be in terms of broader frame-work but not in terms of details, so that the more opportunity we can give to individual initiative and stimulate individual curiosity and individual creative talent, the more we will succeed in the object for which we have out-of-school science activities. Now, therefore, I turn specifically to the needs of developing countries I want to take advantages of the presence of my distinguished colleague, who is deliberately occupying himself in a very modestly obscure position in the back of the hall, but taking advantage of the presence of Dr Nag Chau-

dhari and I am always a person who knows how to exploit the situation even if it causes embarrassment, I want to remind and to mention to this Assembly about him what, I think, the President of the Indian Associa-tion referred, that we want to have a scheme of having Centres in each District Head-quarters in this country where we want to have both science and culture We want science and culture both, because we do not want to give up culture just because we are entering a scientific age. At the samè time, we do not think that culture itself can sur-vive in the modern world unless we are living in a scientific atmosphere and making use of scientific facilities So we want to set up in every district of this country; to begin with at least one such Centre. We have got about 300 districts, each district with a population of a million and half. We want to have in each district headquarters, a Centre for Science and Culture and you know, I am a very greedy person and my ambition always grows to what it feeds on. And since I put this proposal before a Conference of Eminent Scientists presided over by Dr. Nag Chaudhary sometime ago, I would like also to make an addition to this. I think along with this Centre for Science and Culture, which would be exhi-bition, a permanent exhibition, there should also be a hobby centre or a workshop centre where people can come and do some work themselves, where there can be some tools and some materials and so on and those who want to do some work feel interested and stimulated by visiting Centre. To do some work, they can come and spend a few days and do some creative work and so on. We want, these centres to be established in different districts and then organise parties of school students to visit the centres so that in the whole district in due course, every student has an opportunity of visiting the centre and those who get stimulated and particularly inspired may get an opportunity of doing some creative work themselves with the materials and tools that may be made available in the centres I am saying all this, because I hope the recommenda-tions of this conference which was held in New Delhi sometime back, which I specially made it a point to attend and present a paper as a citizen rather than as a Minister of Education, would have included a specific reference to this particular objective and I am anxious also that it will be the kind of thing where the ICC or Unesco can come to help us to set up pilot projects. We have at the moment, four districts in India, where we are having intensive educa-tional development project We are taking the district as a whole and every school in the district is being diagnosed and we are having a very comprehensive programme of trying to link up education with economic and social development in those districts. The idea being later on from the experience that we get, we may be able to extend it to the rest of the country These four districts are:

1. One in Mysore State in Bellary,
2. One in Maharashtra in Jalgaon;
3. One in Punjab in Sangrur, and
4. One in Bihar at Dharbhanga.

Work has already started in all these four districts. In some, work has been proceeding fast and in some, work has not proceeded fast. I should like to have in these four districts, to begin with, pilot projects of scientific and cultural centres and if the ICC, Unesco or whoever are concerned, can be of assistance to us in the establishment of these centres I think that will be a very useful way in which that Assembly could give concrete support to the programme of Out-of-school science

activities. Incidentally, it will also stimulate my own Government to pay respectful attention to the recommendations of the Committee of Scientists, when the Committee of Scientists recommends to my Government that such Centres should be established in each district/town of my country.

Now turning specifically to the needs of developing countries, about which I have already spoken in length but I should like now to say what I have written, that it is time that we all realise that problems of developing countries are fundamentally different from those of the developed countries. The limiting factors for all such activity in developing countries are finance and trained personnel, There is also the need for some foreign exchange Therefore, it is something very important, and I am addressing primarily the Indian members and the members of the developing countries; that developing countries including countries like India have to do their planning for out-door science activities in terms of making the maximum use of their limited trained personnel, and utilising for science activities scrap materials, spare parts from discarbed instruments and equipment, and other presumably waste products. I would like to stress which may or not be of great importance to developing countries, does not necessarily mean that we must spend a great deal of money on hiring the imported first class scientific equipment. I think if we want to spread this activity on an intensive scale in my country or in other developing countries, we should try and make use of all sorts of scrap and waste material and I have been myself some quite exciting products which have been created out of the use of waste material in this country. I think this is something which we want to bear in mind as far as developing countries are concerned. This type of venture which I have mentioned just now calls for innovations, etc., of an entirely new type than the use of standardised scientific equipment, which also I want to do. The developed countries which desire to aid developing countries, have to think in terms of providing experts who can face such challenges and share the joys and sorrows of limited opportunities in the developing countries with the citizens.

May I now wish you all success, in your discussions at this General Assembly at New Delhi so that you could all return home with rewarding and lively memories of my country. May I close Madam Vice-President, with the caustion that, "To define is to limit" Of course, we all must define as scientists but we also know that when it comes to activities of an innovatory character, 'to define is to limit'. Let us at all costs avoid making extra-curricular activities routinized and thus avoid making them into a plate replica of the routinized curricular activities with which we are all so painfully familiar.

I have great pleasure in inaugurating this Session of the General Assembly on the development of out-of-school science activities.

Thank you.

Out-of-School Youth Science Education in Asia

FRANCIS L. WATTIER
Secretary-General of ICC, Brussels

IT has become an evidence, sometimes brutal, that science and technology impregnate little more every day the life of our modern society.

One single figure can prove this statement: about 90 per cent of the scientists of all times are living today I would wish to begin, therefore, by offering for further examination a first theme *The essential link between science and Humanity as a whole:* Humanity without science is blind; science without humanity is void.

Indeed, we must be clear in our minds, that science is a human activity among others, and that it is a part of man's life and culture. This distinction between two cultures gives me much pain and I am referring to C.P Snow's book and may be the following anecdote will lead you to tional humanist culture is presently the only officially recognized and well-established culture.

During a public meeting, to which the so called "cultivated" people had been invited, two speakers were called to take the floor; the first spoke with eloquence and much talent on a subject related to some noble activities of man, in which he excelled speeds as well as in painting, music and literature. At the end of his lecture, the people exclaimed "what a man of great *culture*!"

The second speaker was a distinguished scientist, used to deliver excellent lectures on subjects related to science popularization.

He spoke with talent, the audience understood nearly everything, but they exclaimed, "What a *clever* man".

Do you feel, as I do, the distinction between "culture" and "cleverness". On one hand, culture is reduced to its essentially and traditionally humanist dimension which does not, of course, exclude intelligence, and on the other hand, only intelligence is recognized in the scientist, without giving him the benefit of a cultural background.

This anecdote does not, of course, contain a revealing truth, but it stimulates all of us to a peaceful but decided struggle for the triumph of an enlarged humanism, *the scientific humanism*, which wants a better recognition of the place held by science in modern culture

We revolt against those statements, which were famous in the past. "Science dries up the heart and mind", and also against more recent slogans, as pessimistic as 'Science is not humane".

Keynote address delivered at the Unesco Regional Seminar for Youth Science Activities in Asia. Prepared in Cooperation with Mr R.A Stevens, Chairman of ICC.

Of course, it must be recognized that science sometimes frightens, when it tackles problems like the human body freezing to hibernate it during a whole life, or the possibilities of the modification of the genetic constitution of human beings. These possibilities, enabling science to modify deliberatly the human being, can shake the relative confidence mankind has in science and its applications.

Another often heard reproach science is accused of is the giving of power, the use of atomic energy, to build up the too famous bombs, but with Professor Le Lionnais, President of the Association of Scientific Writers in France "I think that science must be used, and used in a good way". In this sense, the use of a simple knife can be useful or dangerous

Why should science and technology escape the immutable laws of human responsibility. the use made of the discoveries essentially depends on the lucidity and wisdom of man.

Just now, we have listened to some detractors of science, and it is suitable, for obvious reasons of mere justice to play the game and listen to the "scientists riposte" (to mention the French title of a very interesting issue of a recent publication of Unesco—*Impact of Science and Society*, April-June 1970).

There is, of course, the atomic bomb, and there is also the cobalt bomb; and the latest instance of humane application, of the properties of a radio-active isotopes, to fight against one of mankind's plague, the malignant tumours (in particular, cancer).

The essential interdependence of science and humanity is all too often forgotten, both by scientists and by humanists, and yet it is essential. The only thing in which science is helpless is the random chance. But the moment the field of random chance is left behind, there is no problem in which science is irrelevant. The more complex problems of human government, and particularly the planning for the future and for future development, cannot possibly be tackled without taking the help of science. In fact, it is often said that the one cause for optimism about the situation in which we find ourselves today is that it is now possible, through computers, if properly used, to make intelligent forecasts upto decades ahead, which had never been possible before. But note the words "if properly used." If the scientists, using their computers, do not taken into account humanity with its variations and vagaries, they can finish up with results as ridiculous and nonsensical as any reached by the blind unscientific humanity of the past

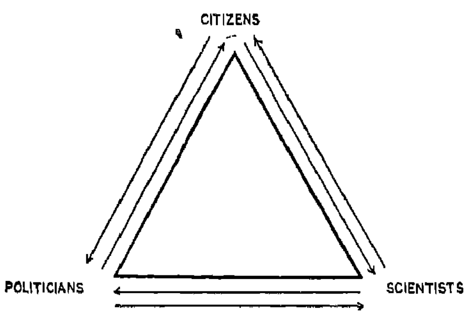
This first theme, "essential link between science and humanity as a whole" leads us necessarily to focus our attention and our energies on the following theme presented under the form of a question, the solution of which, in my opinion, has a vital importance for the future of man: "How is it possible to accelerate the awareness of the place held by science in modern culture, and also, *how to establish a favourable climate for a better comprehension of the special role of science and technology as the main instrument of development*?"

In this context, I would like to quote here an extract of the address by his Royal Highness Prince Philip, Duke of Edinburgh, to the Indian Science Congress in 1959, held at New Delhi. "Every human invention or discovery can be used for good or for evil, and in the end it is the people as a whole who decide which it is to be. It is therefore essential that the possible consequences of scientific research should be put before the forum of ordinary people.

Only in this way can the combined opinion of reasonable, upright and humane men and women throughout the world exert the necessary pressure to ensure that science is used to set free, and not to enslave mankind."

This "combined opinion of reasonable upright and humane men and women" poses, of course, this vital and enduring problems of the survival of democracy in a scientific and technological age, when the vast majority of the people are ignorant of science and technology

To make enable people to "receive and understand" this social impact of science, I would like to present you my "magic triangle" The three summits are held by the citizens, the scientists and men responsible of the political decisions (for reasons of clarity, we shall call them "politicians")



It seems indispensable to me that the direct relations assert themselves more and more between the three summits of the triangle, that dialogues are taking place more every time in the two directions, from the scientists to the citizens and from the citizens to the scientists, from the scientists to the politicians and vice-versa, and from the politicians to the citizens, with the right for these to be better informed of the intentions of the governmental authorities

A generally accepted hypothesis in many countries is that the scientist is led to play a more and more important role in public and political life in order to reduce to the lowest possible level the harmful effects of the applications of science. The governments are appealing more and more to science advisers—technocrats. To ask questions and receive appropriate anwers, is the foundation of the democratic regimes.

"All the powers belong to the Nation": if a citizen is little or ill-informed, principally in the applications of science and technology, can he validly and fully exercise his sovereign duties, and his sacred rights?

We may tackle here the important necessity of scientific popularization of science within the framework of education for young people and adults These problems will be largely studied during our debates But we have to try to answer to the following questions:

What can be presented as science? to whom? how? and by whom? We shall have to estimate the responsibility of the mass media the press, radio and television

Within the great "ICC family", our aim is not at all that everybody starts the study of science and technology, but we would like everyone to acquire sufficient notions as to appreciate the possible consequences and the social effects of science and its applications, in order to use it in a good way

Those are the elements of a situation, that, according to me, demand quick and suitable answers to the questions that were asked Because, have we the right to face passively the possibility of a community in which man would live and understand less, and even without understanding at

all, the world in which he would be condemned to live?

The statement of this deep restlessness is sometimes heard. science has all the characteristics of a perfectly organized religion, and let us excuse this parody· "Besides science, no solution". Also this anxiety, which can be sometimes formulated as: does the so much praised objectivity of science give the scientists the right to avoid any responsibility?

A very important element is science and technology *cause changes in a society which is not yet mentally prepared to receive them*

In the Unesco publication *Impact*, an Indian film producer writes, ".. to import quickly science and technology in an agricultural country like India for instance, it is as if one tried to associate one half of a chariot with one half of a jet." I think that the Mahatma Gandhi said "Machine steals man of his humanity". He was not in favour of the massive import of science and technology because he gave much importance to the humane values, inherent to the Indian rural society

In an article published in July 1969, a few days before his political murder the minister Thomas J Mboya, of the Government of Kenya, gave a "critical survey on the technique and development in Africa". Let us quote "One of the problems which raises the application of science and technology to the life of developing countries is the following· people are informed of the latest conquests of science and technology and they are influenced by them much before they reach them in their daily life. It follows that the populations are carried towards technique much before the conditions and means which would enable to transfer these techniques or to adapt them to face the immediate needs are gathered".

Let me quote a brief extract of the opening speech by Mrs. Indira Gandhi, Prime Minister of India at the CASTASIA—"Conference on the application of science and technology to development in Asia". on August 9, 1968, in New Delhi.

"Though the developing countries have not yet reached the highest level in the field of science, they have one advantage. They sometimes may cover centuries in a few years, take profit out of the experience of the others and perhaps modify the order of evolution The inhabitants of our remote villages know penicillin and the aeroplane has entered some regions in India where the motorcar or even the wheelbarrow were unknown"

We are now at the heart of the matter, and we have to study carefully the question "how to help man to be helped by science?" In particular, for the young generations, how can we proceed to this progressive initiation to the knowledge and understanding of the scientific thinking and technical achievements. The thoughts are expressed taking into account the proper conditions of the Asian countries.

We shall consider successively the *school science education and the out-of-school science education* showing their own features and above all, their complementarity. I have included science education, that is, formal in-school science education, because this is an essential basis of the first theme If humanity without science is blind, there must be science education if eyes are to be opened. Moreover, we cannot proceed to consider the place and role of out-of-school science education unless and until we have considered some of the difficulties of formal science education in Asian countries.

We have logically to ascertain that science education in most countries in

Asia is an alien affair. Great and glorious though the culture and history of Asia, they do not include modern Science and technology as an essential indigenous characteristic. It follows that modern science and technology education has had to develop in Asia as an alien affair, often conducted in a foreign language, mainly using a foreign syllabus and foreign textbooks, often aiming at a foreign examination.

One must confess to very great and real sympathy for the science teachers of these countries, and those directing them. They has to do *something*, and what better could they do than follow the prescribed syllabus for the examination for which their students were being prepared. It must be admitted also that the help they were given from other countries was not as good as it might have been. I will give just one example from Great Britain although I have no doubt it could be duplicated from many other countries. Only a very few years ago, a group of eminent university chemists undertook an analysis of the questions set for the General Certificate of Education in chemistry, and established that well over ninety per cent of the questions could and should have been set fifty years ago. Chemistry was treated almost exclusively in terms of the properties of some nine metals, and there was no hint in any of the papers of all the exciting new work of the past thirty years—the nature of chemical bonds, the basis of ion exchange, how and why reactions take place, how catalysts work as they do, the whole field of stereo-chemistry (why two isomers, with exactly the same number of atoms put together in a different way have completely different properties) all the work which has revived chemistry and taken it rushing into exciting invasions of both physics and biology

There are two truths here The first is that the ferment of progress in formal science education has been so recent, and so rapid in its growth and acceleration, that it has tended to obscure the position in the countries of Asia rather than to assist. In a confused and very rapidly changing position, there is an inevitable tendency to stick to what is known, and to resist change.

The second truth leads directly to the place and role of out-of-school science education, not only in Asia, but throughout the world This is that there is, inevitably and universally, a built-in time-lag between what is taught in formal science education and the frontiers of knowledge; and that this time lag is far more apparent, and far more serious, in science than in any other subject. A history textbook of 1910 is probably still today a reasonably accurate guide to history, at least up to 1980 or so A chemistry textbook of 1910 is a museum piece. Many cases could be cited of textbooks, published very recently and still actively in use in schools, which should be museum pieces, so obsolete and inaccurate are they. Science is advancing so fast that any system of formal education based on a syllabus, on textbooks and on examination requirements, *must* be several years behind the frontiers of knowledge And if forced to put a quantitative value on the word "several" it would probably prove surprising and embarrassing. Out of the conclusions and recommendations of CAST-ASIA related to the "improvement of science education in the Asian countries" I have taken:

—the science education policy must be considered as making integral part of the national policy of the education development, of which it is an essential element,

—from primary education, one must try

to give the children a scientific mind rather than having them retain facts, and the scientific education must be based on the direct experience of the school children and remain in relation with their environment, preservation of natural resources, hygiene food.

Our deep conviction of the complementary qualities of the out-of-school science education will be easily proved by another proposal contained in the report of the CASTASIA, ". . the creation of science clubs should be considered as an essential element of the science education programme, and as a means of providing for young people the opportunity of taking profit of this scientific curiosity out of the school framework". So, once more, at the instance of the governmental or non-governmental Authorities, the *need to institutionalize the out-of-school science education* is officially proclaimed.

The "International Conference on Youth" organized by Unesco at Grenoble, France, August 1964, had already underlined this need, " ... the youth school and out-of-school educations have the same legitimate right to be included in the general development plans and to profit of the material resources of the nations... "

In the first "Report on the situation and needs of the developing countries in the field of out-of-school science activities", I have expressed some thoughts on the conditions of the development of out-of-school science education in the African, Asian, Latin, American countries. A few of there are:

(1) the out-of-school science education has an important role in awakening the interest of young people for the study of science and in the acquisition of a scientific, critical and logical science and in the acquisition of a scientific, critical and logical *attitude* It is necessary to develop the process of demystification of science and to suppress any supernatural features of it

During my visit to 7 Asian countries in 1968, under the auspices of Unesco, I brought back, among others, a booklet published by the Birla Industrial and Technological Museum at Calcutta, which is very significant in this respect: one can see a magician touching with his famous want the installations of the Museum, under the legend· "Magic? No, this is science". At the entrance of the Musuem, some explanations are given, related to practical experiences which might have appeared supernatural at first sight. It is in this direction of the objective analysis of logical observation that the out-of-school science activities must be created

(2) In a report she presented during our first World Assemly in Tunis in November 1967, Mrs. M.J.S. Ormastroni, Executive Director, IBECC and Vice-President of ICC for Latin America, has emphasized more particularly the objectives of the Latin-American associations; "to encourage the creation of clubs as well as the activities within the reality of the developing countries". What does that mean? In our opinion, the acquisition and/or the re-enforcement of the scientific mind are more important than the research of immediate and spectacular *achievements.* Many times, I have had the opportunity in Asia in 1968 and during a more recent mission as Unesco consultant expert in Upper Volta (in Africa), to see that the attractive and dramatic role of the works can often be found in the greatest simplicity.

The agenda, of this Unesco Asian

Seminar will lead us to study the impact of *scientific infrastructure* (scientific libraries, lecturers museums of sciences and technology ....), and many other problems in particular, that of the *young talent search*, of the training of enterprising minds, which must have both more extended knowledge and a larger broadening of mind

I do not intend to discuss these questions now, but for the last point mentioned, I would like to quote a short extract from the communication of Prof V. Korotov, Academy of Pedagogical Sciences, U.S S R made at Montreal in August 1967, at the "First World Conference for leaders of scientific activities", organized by ICC with the financial help of Unesco · " . .the tremendous discoveries in science are often made by the youngest representives Because routine, stagnation are irrelevant to them; because a revolutionary enterprising mind is proper to youth in all the spheres in the life of society, and of course, in science. . . ." But the most fundamental point is, that the Asian country want to develop the out-of-school science activities for young people not only with the desire of the scientific and technical acquisition, but also by placing *these activities in the context of the social and economic development*, they desire achievements that may accelerate the well-being of the community. This aspect is clearly emphasized in the working paper presented for this Seminar, in these words how fare out-of-school science activities should be integrated in social and economic development (particularly in the view of the CASTASIA recommendation, that efforts to implant science and technology should be directed first of all, on a massive scale, to agriculture, in other words, how to involve youth in the "green revolution" and the search for solutions adapted to their own country?

The leading role of the science teacher or of the science adviser has already been underlined very often. The science teacher in Asian countries not only has to teach science, with all the handicaps which have already been noted he has also somehow to convey understanding over very wide field. And in addition he has to make the whole, knowledge and understanding, relevant to the problems of development; to transmit the idea that, for every student of science (no matter what his subject or speciality) there is in his own country a lifetime of interesting and indeed absorbing work to be done, helping the development of the country, to secure acceptance of the idea that the opportunity to learn science or technology carries with it almost an obligation to consider service in the development of one's own country, or at any rate of Asia as a first priority.

I often feel that, in this matter, priorities are not correctly assessed in this context Too often, prestige research projects are undertaken, at great expenses, which duplicate work done elsewhere, and in any event add little or nothing to the development of the country. Too often, the aim of many who qualify is to escape to some postgraduate post in another continent and to flee from the tremendous challenge of development work at home Countries with a highly developed scientific and technological system complain of "the brain drain". Their brain drain is nothing compared with that of countries in Asia, where there is a desperate need for every qualified man.

What can the science teacher do about this? As far as we in ICC can see, the best chance to do something about it is through out-of-school science activities. The syllabus must, in the present circumstances, be covered in class, in school; and out-of-school activities must be used to

supplement the syllabus by making the science that is taught relevant to the situation and environment of the country concerned. Inevitably, in response to this "must", the cry will go up, "But how? But how?"

It is a difficult task—a very difficult task; but it is not beyond solution

The first requirement, I would submit, is that which has been encountered in many countries when it tries to introduce an approach to science in the primary school, using primary school teachers with almost no scientific background for the purpose. These teachers were not, and could not be, science teachers; and specifically they were not asked to be science teachers. The work of Piaget, as to the age at which formal science teaching and scientific concepts should be introduced, is still valid, and the last thing one wants to see in Primary schools is what was suggested by one eminent man—a formal teaching process starting at age 5 and carrying on to 11. What we did want these primary school teachers to do, not being scientists, was that they should turn themselves once again into little children, and lead the children in *finding out* For this, the first essential is to admit frankly that teacher also *does not know*; and from this joint basis of ignorance, to start to find out.

In the case of the science teacher, of course, there is not ignorance—there is knowledge. But still, ignorance must be to a certain extent feigned; it must not become a lesson—imparting knowledge. It must be a process of encouraging the young people to find out and do the job themselves. This is sometimes a very difficult task, calling for much understanding and patience.

The second requirement is also something that has been taken in many cases from the work of the approach to science in the primary school, but which is also most important in the sort of work we have in mind for secondary schools in Asia. As far as possible, the project or investigation should arise out of the experience and environment of the young people. Provided this is the case, it does not greatly matter what the subject is. It is the *approach* which is important, so that the investigation shall be seen as something which is scientific, and which is relevant. Observe, measure and record, then if you can state a hypothesis, test it. This is the scientific method, and provided that it is applied to a problem arising out of the environment and from experience it will be meaningful for the purposes we have in mind

It follows for instance, that the experience and the environment and very often the subject for an out-of-school activity will be quite remote from the syllabus. This does not matter, in fact, it may be a positive benefit, for it will tend to show, as well the wealth and breadth of science, the relevance of science.

There are probably many activities already going on in schools which can be made the subject of an out-of-school science activity. For example, a school farm if scientifically approached can become a very scientific activity, with carefully observed records of planting, germination and growth, the effect of fertilisation and irrigation, controlled experiments between different varieties of seeds, and even a comparison of results with the experimental farms of the government agricultural department. I know that in Africa the agricultural officers would have been only too delighted to collaborate with schools in this sort of scientific work The same may well be true of many of the meteorological records which schools keep. For every schools which makes sensible meteo-

rological scientific use of the figures obtained, and compares them with other schools results, there must be hundreds which just go through the motions without making any real use of the work.

It follows from this that many very valuable investigations may lead teachers far away from the subjects which they normally teach formally. We can easily find a whole range of most important science investigations which could very well, and very beneficially, be undertaken by schools or clubs. It would, for example, be possible to undertake sample, and of course unofficial census records of a village, which could be of the greatest use (again, unofficially of course) over a period of years. It would be possible to undertake records of land use, and of areas planted under various crops year by year, with the yields obtained; and these could be correlated with meteorological data. It would be possible to undertake long-term investigations of plant sociology, and the effects of pests. It would be possible to undertake sociological investigations, even if it is only the number of children brought into a rural welfare clinic, and the motivation behind an increase, in attendance. It would be possible to undertake an investigation of a local market, with variations in producer and consumer goods offered for sale, prices, and numbers of traders and customers attending, from where they came, and how often, leading to an idea of the traffic patterns of the commerce of the areas.

Experience with community development activities in many parts of the world has shown how effective, and beneficial for a community, can be collaboration between young people with the benefits of education and older people of authority in the community but without the benefits of formal education. There are many, many ways in which out-of-school scientific investigations could be tied up with community development projects to the benefits of all. Such a project might be a new road; in which case it may be vital to know the level of flood water in the rainy season, the rate of flow at a given point (showing whether a bridge is required or whether a culvert will suffice) correlated with the meterological data for the area.

I hope that these examples will suffice, for this keynote speech, the sort of simple out-of-school scientific investigation which is in the highest degree effective in showing the relevance of science to problems of developments, and how the knowledge, and the approach, which are taught in formal science classes can be brought to bear upon the solution of local problems. If this sort of activity can be made, and become part of the normal experience of every pupil in school, the benefits for the country where it happens, brought about by the teachers and the pupils of the country themselves without any expensive apparatus will be enormous. And the benefits for the future, in arresting the brain drain, and in encouraging the scientists trained in the country and the non-scientists, to understand how science can and must be used to accelerate progress, will be even greater.

At the end let me emphasize that formal there should be science education for otherwise there will be no scientists. But the greatest good will not, and cannot come from formal science education alone. It can only come from well-planned and well-led, out-of-school science activities, in which all join, whether they are going to be scientists or not.

Only in this way can science be truely used, as Anderson said in his will, "for the good of mankind". Only in this way, through out-of-school science activities,

can young people truely and effectively contribute to the advancement of science, and of their own countries. Before concluding I cannot resist the desire to reproduce a poem published about 25 centuries ago by an Asian poet Kuan-tzu. I have read the French translation and I try to give an English version. You will forgive me if it has lost a little of its poetic rigor, but it has kept all its depth and actuality.

"If your projects will cover one year, sow grain,
If they cover 10 years, plant a tree
If they cover one hundred years, instruct the people.

If you sow grain once, you will harvest once
If you plant a tree, you will win ten times
If you instruct the people, you will win a hundred times."

Out-of-School Activity Through Field Problems Connected with Development

M. ATPUTHANATHAN
Ceylon

IN this paper a new strategy in science education is presented where science learning is programmed through field-work Shortcomings of practical work in school laboratories are now well known and this is one of the trends in reorientation through new approach The test for experimentation by youth can be maintained through scientific investigation in which the results cannot be predicted in advance. Such work really stimulates a process of genuine scientific research.

Field-work in secondary education (Level II) was confined to the teaching of botany and zoology and in the primary (Level I) to nature study. These took the form of school picnics and the incidental collection of specimens. There was little follow up. After the second world war, biology as an integrated life science gained ground in the secondary school with the emergence of "ecology" which is defined by Hoeckel (1866) as "that which deals with nature's household", by Elton (1927) as "scientific natural history"; and by Odum (1963) as "the study of the structure and function of nature". The ecologist has now ramified into geology, geography, pedology, climatology, mathematics, etc., in addition to biology, chemistry and physics.

In order to help the pupil to look at nature (Level II) as an integrated whole, instead of compartmentalized subjects, life is made the central theme and sciences like physics, chemistry, geology, etc., are to be interwoven in the fabric of knowledge

Knowledge of nature ranges from atom to universe, and hence students must be made to look at them as entities of knowledge or complex systems The nature surrounding the student with problems familiar to the teacher and the taught forms a convenient point to enter this complex system and learn to unravel it.

Field-work has other advantages in that it involves familiar materials, loss of abstractions, needs simple equipments; yields to experimentations; leads to improvisation; problems are open-ended; it is away from the tyranny of rigid time table and other restrictions; relieves the teacher from taking special steps for motivating, brings healthy social relationship amongst those working; and also between those working and the community around. In addition this provides source material for research by teachers and students.

The Hydrobiology of the Thondiamannar lagoon (in the northern part of Ceylon) which was blocked by Government Irrigation Department to reclaim land and provide a source of fresh water formed the *field problem* The investigations that were carried out by us with the active help of the community around were appreciated by the

officials of the Irrigation, Agriculture and Fisheries Departments.

The Hydrobiological Survey Research Council laid down its policy after a series of field studies by teachers and students. Thus: "The main objective of the council is to plan and execute research, foster research among teachers and students and experiment on better science education through the integration of science provided by the problem in the field". The programme took the following pattern: Projects both at teacher and student levels, surveys, educational experiments; seminars, training courses, discussions, teaching sessions and discourses. The results of these investigations were to be published periodically. A field-work centre complex is to be established to facilitate the effective implementations of the programme. This is in short the policy of the council

Implications of Science Teaching

One of the chief defects of the science education in the developing countries is that it is unrelated to life in general, it is more academic than practical By getting students from various schools to come out in the field for two days with teachers, they are made to look at problems. They use simple science apparatus and look at sophisticated apparatus, too This enables them to develop a healthy scientific attitude. Once this attitude is developed, the teaching and learning becomes easy Batches of students are taken twice a year and they

Sorting out biological specimens in the Outdoor Science Camp

work with teachers day and night as working companions. By working on problems in the field they get an experience in scientific method Students were found to suggest improvements to techniques and to plan out ways of tackling problems

Another big drawback in our educational structure is the attitude to research. The Royal Society rightly felt that it would be started in school. In our field camps a spectrum of problems are thrown for students to work on. Interested students are taken by teachers to help them in their research projects. Thus in addition to the students trying out miniature research projects, they help teachers in their research problems. There are others who watch and incidentally learn as some of their colleagues and teachers work on research problems.

The scientific attitude thus created, makes students to work on projects for school science exhibition. An Inter-school science exhibition, mainly among the schools involved in this programme, is organised biannually Students are also encouraged to become members of scientific bodies such as Junior Ceylon Association for Advancement of Science to promote research among students, Junior Wild Life Protection Society, and the like. It is very interesting to see some students who were trained in our camps not only becoming members of these bodies but actively contributing to them.

Teachers who are involved in it have become well acquainted with the modern techniques and some of them have produced research material acceptable by the highest scientific body in the island and some of them are accepted by universities in the United States of America and Czechoslovakia, where these teachers went to further their education. It has been the common experience that many other teachers who come to see these field activities become motivated and some of them joined as full-fledged members of this field-work group. This has made the teaching by these teachers more competent, lively and purposive. The children who participated in it are leaders in the classroom and they revitalise the classroom and laboratory activity.

One problem that should be brought home to the youth particularly in Asia is the idea of conservation of nature. The students who work in the field get first-hand information and training in conservation. The laymen who come in contact imbibe these ideas.

The non-science students who accompany us as scouts and helpers learnt a great deal and they too used to assist science students in taking measurements and going on observation parties. This is one way of imparting some science knowledge and the scientific method to the non-science students.

These are some of the main educational outcomes of the experimental project on field activity in science education

Social Implications

It was never realised initially that what was started as a primary research-cum-educational project, could be of interest to the community at large The recognition of the value and experience gained by our members on the board set up to advise and carry out investigation on the water resources of the Jaffna peninsula (a place that depends purely on subterranean water supply trapped in Miocene rocks).

Problems were suggested to us by the fisheries experts and our research findings have found the way into Fisheries Research Station. Agricultural extension work helped by the soil and hydrological data provided by us. There has been request by farmers and fishermen of the area for information

on water salinity, the type of the lagoon etc. The Irrigation Department constantly keeps in touch with us and the informations are exchanged They have made available some of their equipment for our use.

Popularisation of science attempted by the Ceylon Association for the Advancement of Science was a failure because people are not prepared to come and listen to lectures or Radio talks on science in Ceylon. It was found that those who came to listen to popular talks were science youth and not non-science people. Further, very few people tune to listen to radio discourses in science. On the other hand, it was found that by working on scientific problems related to community interest, we could popularise science by incidental learning, by observing others' work, giving information and by dialogue. It was a common occurance to see people congregating at the four camp sites situated over a distance of 30 miles, each in a different village. There always was a curious crowd watching the work. They get into conversation with teachers and students. They carry this information to the others and by this way we were able to create an awareness among the local population. In turn they offered us help in various ways. Even the finance required to put up the field-work complex is being obtained by the collections from public. We were able to put across the idea that shooting of the birds unnecessarily is a loss to their beautiful village (two of the villages has bird roosting grounds and are abundant in migrating birds). Our science exhibitions are patronised well and thousands of children and parents view the exhibits

Another social element that we soon realised, as well worked through this programme, was the experience in group living that children get They usually come from different schools and each working stations used to have students from five or six schools. This gives them opportunity to exchange ideas, experiences and work as a team. In every team there is normally included a scout team and they look after construction, food, transport, etc, of the camp. There is a possibility of scouts learning science and others seeing scouts in action. We normally put students in the forefront of organisations and this gives them a training in leadership, discipline and responsibility.

Further children work as work mates with teachers and this gives an opportunity for the teachers to understand them better in classroom and laboratory as well

The Physical Plant

The physical plant that ran this programme originated as a sub-body of the Science Teachers Association of the North of Ceylon The idea of getting teachers and students to work on the lagoon that was expected to get converted into a freshwater lake was the primary objective The information thus obtained was meant to be channelled to the relevant bodies such as agriculture, irrigation and fisheries while experience thus gained was to form the backbone of science educations

Experience showed that the centre of activity should not be the school, but the interested teacher. This was realised very early and this proved very useful in the implementation of the programme from 1963 onwards The sub-body grew into a Research Council with a convener, and this body began to function as an autonomous body with the good wishes of the Science Teachers Association Only interested teachers were to become members of the council. They had to pay 3 rupees (3 shillings) per month to run this organisation. The preliminary work covering the first two years

gave enough materials for research. This lead to members in closer contact with other research organisation such as universities, fisheries, research station, Ceylon Institute of Scientific and Curriculum Development, Centre of the Ministry of Education The work increased and it had to have one member as Secretary to run the organisation, a treasurer to look after finance and publication and another assistant to the convener to organise surveys.

The composition of the council is made up of teachers and others interested who are called project assistants and people who have made definitive contribution to research and organisation of surveys called project officers. One of the project officers is the convener of the council At present there are 23 members of the council, and 19 schools are participating in this project.

Twice a year field camps are established, simultaneously at four stations, and the work teams camp out from one morning to the following day afternoon These surveys are financed by the participating schools. The Ministry of Education provides all assistance by way of transport, equipment, chemicals and encouragement Follow-up work is continued in schools and by meetings of the council Some problems arising out of the general study is continued as research problems by teachers and others interested; and some are worked as student projects These are financed by the council funds There is a small laboratory for the council in one school where all scientific collections, equipments and books are stored and where council meets every month.

Various organisations have helped in different ways. The Ministry of Education Secondary Division gave all encouragement and made available equipments, chemicals and above all Mr B.J. Alles, Deputy Director-General Secondary Education and Mr J Rathayake, Chief Education Officer (Curriculum) gave advice and constructive criticism. The Asia Foundation got down some equipments and books which were not available in Ceylon. They also made a small fund for the publications. British Council also had made available some books Besides these, expert advice from interested friends in the universities, research stations and sometimes from public too were available

The Budget of the project is increasing year by year For the year 1969-1970 the figure stands at about Rs 4,000 Part of this is met by schools and part by members of the council by way of monthly contribution and rest by donations This excludes the cost involved in chemicals and fuel for vehicles which are met from Ministry funds It is estimated that once the field-work laboratories comes into operation the cost will increase by another Rs. 2,000. Thus the total cost of running this programme excluding chemicals and fuel for travelling works out to approximately Rs. 6,000 (i.e. about £ 460).

From this year onwards a monthly *Newsletter* is being circulated to keep our members informed of developments in the council and in the field of science It is also to provide a forum to discuss the work that is going on This *Newsletter* is sent free to all members, member schools and others, interested.

The council also publishes bulletins to bring out the outcomes of research and educational experiments. Seven such bulletins have been published from the funds made available by the Asia Foundation of United States of America.

Other features are the radio talks to which the members are invited by Ceylon Broadcasting Corporation Two such discussions have taken place Science Con-

gress was organised to get students to present their papers on miniature research problems. Three such science congresses were organised by the science teachers associations.

The science teachers association also helps the council in whatever it could

Research Quality

Though emphasis was on field activity to provide source materials for science education and investigation The problems studied by teachers were judged to be of high standard. This is replaced by the following papers that accepted to be read before the Ceylon Association for the Advancement of Science (The highest science body in Ceylon)

1. The Preliminary Report on the Hydrobiological Survey of Thondamannai Lagoon (1965, Atputhanathan M , Kugathasan, K S. and Gunaratnam, K)
2. Observations of Some of the Biological Factors and Distribution of Pontodiilus Bermudensis, Beddard 1891 (1967 Atputhanathan M, Unesco -CAAS Science Teacher Award 1967- -Presentation Address).
3. Observations on Bioluminescence of a Marine Warm, Odontosyllis Grovelyi Faurd, 1928, off Northern Coat (1963—Atputhanathan, M).
4. Fish population of Thondamannai Lagoon-- Its Distribution and Economic Potential (Atputhanathan, M, Chitravadivelu, K., December 1968).
5. Distribution of Mangrove vegetation in the Thondamnnar Lagoon (1968, Kugathasan K.S.).
6. Prawns of the Thondamannar Lagoon- -A Study of the Different Species, their Migrational Behaviour, Pattern of Distribution, Breeding and Economic Potential (1969, Chitravadivelu K, Selvavenayagam, K.)

Besides these there are other papers such as·

1 Investigation of the Technique of Determining- Oxygen Concentiation in Water.
2 Preliminary Report of Elephant Pass Lagoon.
3 Student project Trials, 1, 2 and 3
4. Evolution of the Organisation of the Hydrobiological programme

This shows that incentive for high quality work by teachers and those interested in science could be initiated by facing problems in the field One wonders whether these investigations would ever have been initiated if these people had not worked in the field and seen the problem emerging from the preliminary information that was being gathered.

Field-Work Complex

The field-work complex is the outdoor activity centre of the Research Council. The laboratory which is nearing completion on a half acre site will have an office-cum-library, an equipment room, a dark preparation and balance room, space for practical work, and toilet facilities The space for practical work has four corners one for biology, one for physics, one for chemistry and one for geology and geography. There will be a space underneath the building which is on stills for the boat, for storage of camping materials and for keeping experimental material.

The next block of building to be constructed is expected to accommodate a lecture-cum-discussion theatre and two rooms for use as production units.

Four tanks are planned to be constructed with facilities to bring animals directly from lagoon and for experiments. Adjoining this there will be an out-house for experimental set-ups.

Four huts are expected to be put up for students to come and stay, in addition to the camping facilities that are to be provided These huts are also to serve those who want to do research to come and stay.

This complex is to serve as a centre for out door activity for students doing science. But unlike other field-work centres, this also has space assigned for those who want to come and work on projects There will be project tables which will be assigned to each of these research workers.

A full time laboratory attendant will look after the centre In time to come it is proposed to put forward a proposal to the Ministry of Education to station a full time qualified person to guide those who come to this centre

Conclusion

This new venture in the field of science education, started primarily as an investigation of the changing Hydro-geology of the lagoon, got crystalised after preliminary work into one of a new strategy in science education. This work has been going on for the past seven years, from 1963 This approach has made the teachers fairly modern , both in their approach and in their subject content It also found that the normal teacher, as years pass by, his quality of performance decreased; but in the case of those involved in this programme it has been increasing. It appears that, this not only motivates the student but also motivates the teachers in enabling him to perform at a high level of adequacy.

One of the important features is that in addition to students and teachers quite a number of educationists, Research Officers in different fields and laymen to science are involved in some way or other. It is our firm conviction that besides better science education, development of research attitude, popularisation of science; education with a hearing on community problems are being achieved by this programme

Thus we present this programme with its experience and data at this session as a model for consideration for organisation of out-of-school activities for youth, with particular reference to problems around the community, whether it be rural or urban in a developing country.

Additional Out-of-School Science Activity Programme for Ceylon

1 The programme that was described to you in the paper was tried out in the northern part of Ceylon. Its success in the field of science education, popularisation of science creativity, social implications and above all relationship of the programme to countries development programmes were shown.

Two other programme were thought of on the advice of the Curriculum Development Centre whereby science teachers in two other parts of Ceylon could be catalysed to embark on a programme of this type.

2. The development programme isolated for Kandy, the Central hilly area of Ceylon is "Water Pollution". We visited this place and had a series of consultation with teachers. This area is fed by water from Mahaveli Ganga; and water from the Kandy lake is also of interest to the community

Though this problem was isolated from our experiences of working on Thondamannar lagoon. We have decided not to start it ourself, but to stimulate the teachers and others interested in that area (Kandy) to organise themselves to embark on it.

Methods like bringing a group of teachers to see the Thondamannar project, taking them to discuss with experts in this field are contemplated to stimulate them to action.

3. In the South of Ceylon in Galle Area the problem that appear be of interest to community is Coir Industry The Rural population has a hand in it and the urban population also is interested in it. In addi-

Chemical analysis in the Outdoor Science Camp

tion to the main industry there, are other side effects of coir industry which the people are worried about like infection, etc., from coir soaking pits.

Here again the same method as thought out for Kandy is contemplated to get teachers to lead the programme.

4. Once these two areas are stimulated to start their programmes, we would have three programmes related to community interest one in north, one in central part and one in southern part of Ceylon going on as out-of-school activities. From our experiences of Lagoon Project in North, we have no doubt that the other two also will produce the desired outcomes as was laid out in the paper

5. There are at present a large number of science clubs functioning in different schools where enterprising teachers are available.

From last year onwards there is a move to coordinate the activities of the science clubs by forming Junior Association for the Advancement of Science in each of the 15 regions into which Ceylon is divided. Already such bodies have been formed in two regions

6. There is a move to develop the new existing Junior Wild Life Protection Society Through the science clubs and projects region-wise.

Because, with green revolution, nature conservation in the small island is becoming a great problem, and it has become necessary to educate the youngsters and through them the adults too.

Scope for Cooperation to the Contribution of Out-of-School Science Education to Development

S DORAISWAMI

Member, Commission on Education of the IUCN

AT the outset, I thank Dr. Wattier for extending an invitation to the IUCN (International Union for Conservation of Nature and Natural Resources) and to be represented at this Asian Seminar on Youth Science Activities as well as in the General Assembly of the ICC later on. I also thank Dr. Dudowaki, Director-General of the IUCN, who has asked me to represent the organization at this meeting, for exploring the possibility of cooperation and coordination between the two organizations Before going further, I would like to introduce myself. I am in the Department of Science Education in the NCERT, and last year when the General Assembly of the IUCN met here, I was nominated a delegate by the Ministry of Education in the Government of India to participate at the conference At the executive meeting of the IUCN, I was elected as a member of the Commission on Education of the IUCN.

I have been listening to the very interesting discussions and reports of the distinguished delegates for the past three days, and I find that the out-of-school activities as provided here are admirably suited to the aims and objectives of the IUCN also. The Commission on Education of IUCN is specially interested as it has to propagate the teaching of environmental and conservation education to the children at all the stages in the schools as well as in the colleges The IUCN, like the ICC, is an international non-governmental organisation, but it has governments as its members and other institutional organisations The Government of India became a member of the IUCN at the last General Assembly. The Assembly passed a few resolutions and requested all members (government and organisational) to implement them. The interest generated by this meeting in the public is reflected in the number of parliamentary questions which have been asked on the resolutions passed by IUCN assembly and the way that the Government of India, through the Ministry of Education, proposes to follow up so far as school education is concerned. And I should say the response from the Ministry of Education and NCERT is very heartening, because they have taken it as one of the items of their programme and the follow-up work is being pursued.

As a first step, the IUCN has asked me to be the Convenor in forming an Indian Regional Committee of the Commission on Education Steps are being taken and arrangements are being made to have an inaugural function of this body on the 14th of January, 1971 in Delhi. The idea of the IUCN is that after working for a year, this Committee should be enlarged into the Regional Committee for South Asia, because in the IUCN Commission on Education, there are Regional Committees for several regions and not one national committee. The countries in the region may

have common problems of environment. When I was asked to do this, I was a little perplexed, and I asked myself, "Where are my contacts?" But I am very happy that I have been involved in this meeting and I find so many contacts in this fruitful co-operation between the IUCN and ICC. After hearing the excellent paper from the learned Ceylon representative it was very heartening for me to know how the students are being involved in major problems of the country.

Mr. Atputhanathan kept us all interested on a very useful project he has been working on in Ceylon. If we could only isolate or recognises certain situations like this in our different countries, we can also involve the school children in out-of-school activities. It is here that the pupils can show individuality, initiative and appeal to the masses.

As a follow-up of the General Assembly meeting of the IUCN, there was another meeting, a Working Meeting on "Environmental Education in the School Curriculum" at Nevada U.S.A. The Ministry ones again deputed me to attend this meeting. At this meeting the problems were examined from several aspects. One was the development of curriculum where concepts of environmental education could be introduced at the different stages of education; and another was the out-of-school activities. It is best to involve the young pupils and the youth in conservation education. Scientific literacy has been explained by our worthy friends here and this should also include awareness of environmental problems. Several delegates touched upon this aspect as part of the out-of-school activities. Where else can we begin it except at the school stage when children are young, and inculcate in them the necessity to preserve the balance in nature and the necessity to maintain it if man is to survive?

It may apparently appear that India is not now so affected as several other developed countries. Still I think we should take steps even from now so that we should take advantage, and benefit from the mistake of others. There was a time when conservation education meant only the conservation of moisture, conservation of soil, conservation of forests and preservation of wild life, and so on. Environmental education now has a wider meaning Perhaps man is the only organism, that consciously changes the conditions of the environment. It includes the urban situation. His action affects both the renewable and non-renewable resources of the earth, and on the wise use of these depends the survival of men.

The term "ecology" has become very popular and fashionable. There was a time when "ecology" was used only by the biologists in the classrooms, but I think "ecology" is now being used by the public. The American magazine "Life" once published a photograph of a model wearing an "ecology" dress. The awareness of this aspect is very acute in some advanced countries, where everyday the newspapers have some feature of other about environmental problems, and pollution in the big cities and in urban situation. Conservation is no longer the realm of biologists, it is being discussed in other science disciplines. This has a multidisciplinary approach.

If these points are somehow brought into the school curricular materials of the different disciplines, and if those are again tackled as out-of-school activities, much could be done with regard to achieving our objective of maintaining an environment for the future survival of man.

Another feature that could be noticed is the forment of curricular revision that is going on in all the countries. I mean parti-

cularly the developing countries. We had a good idea of what is happening in Ceylon, in Singapore, in Malaysia and other countries. India is also involved in a great project and task of curricular revision, and improvement of teaching of science in our schools. We had an excellent picture given by one of our distinguished guests about how the question paper that was set in England was examined and found it was 30 years behind the times. How I am happy to say that we are not so behind in times but are catching up rapidly. We are in the wake of the other nations in the revision of our syllabus and we have undertaken a big project In the light of the discussions here and with the background we have, we have to develop our extra-curricular activities In India the Ministry of Education is encouraging the setting up of "Youth Camps" which should only work on out-of-school activities. Among other activities the camps could include activities to propagate ideas of preservation of the environment as well as out-of-school science activities.

In our universities, there are National Service Crops for which also camps are organised. In the Banaras Hindu University, where there is an ecology school the faculty members have started putting this across to the NSC so that they could make this as a part of their programme and I hear they are doing good work All these aspects would be examined by us at the business session after the inauguration of the Indian Regional Committee in January. After that we would request an expert committee to examine our existing curricular materials to see how much of the concepts on environmental education they have and what new ones could be introduced without disturbing the structure of the disciplines or the curriculum.

One of the out-of-school activity would be the organising of exhibitions and "green-weeks" At Nevada we were shown pictures of how the children were involved in these activities in Sweden and Netherlands. Perhaps we could also proceed on those lines and the Forest Department has extended full cooperation to us to implement this programme and produce filmstrips, slides and so on.

I was very happy to find that many of the activities of the ICC and the out-of-school programme in the other countries are giving attention to the environmental and pollution problems I could see at least two major planes where we could cooperate. (i) IUCN would be furthering the out-of-school activities because it is one of their important objectives., (ii) the ICC would be helping to implement the objectives of IUCN as far as involvement of school children is concerned.

Glossary of Technical Terms

I find that already a beginning has been made in the ICC. It is one of the items suggested by the Indian Regional Committee at the recent meeting of IUCN at Bulgaria, that there should be a glossary of ecological terms and this was approved. They have asked the Indian Regional Committee to start it In this also I see a lot of cooperation.

Perhaps in the beginning the cooperation will be all one way. We will be taking in more but ultimately I hope that we would be able to restore a two-way traffic.

The Science Foundation of the Philippines : Its Experience at Science Promotions

SOLEDAD L. ANTIOLA
Executive Director
Science Foundation of the Philippines
Manila

AS Executive Director of the Science Foundation of the Philippines, I came to this august Seminar more to listen than to be heard, more to acquire than to impart. For, my country, the Republic of the Philippines, is an old young country—old in historic years but young in science experiences, particularly on youth activities. We are just beginning.

It is, therefore, with great sincerity that I express for myself and for my country deep gratitude for having been invited to this seminar for we are eager to learn from you of your advances in science, particularly through out-of-school youth movements and/or of your problems and how you solve them so that I may bring them home to my people and benefit thereby.

Of course, I am going to speak about my country and its problem and the steps taken so far to approach national development through our out-of-school science education. I shall be honest and to the point in talking about my country. Like an ordinary physician I am taking to you, a patient, for a conference diagnosis by eminent colleagues

Paper presented at the Unesco Regional Seminar for the Leaders of Youth Sciences Activities New Delhi, 15 to 18 December 1970

Throes of Growth

My country is undergoing painful difficulties of a stunted growth along sociological, economic, political, educational and technological lines We stumble along, clumsily with a heavy load of biased and outmoded policies. We have to drag and pull in order to go ahead.

We desire to progress as fast as our people's needs demand However, efforts we make turn clumsy, sophomoric, inefficient and inutile not much by our own choice and design, but more so by inelastic sub-servience to outmoded concepts. However, we have developed an attitude of feeling disgraced or inadequate when anything in the guise of local or native colour springs up—to be competed with what is foreign—an apparent betrayal in the Filipino including the supposedly nationalistic leaders, of his inner values.

We have the sad spectacle of our experts in science and technology being lured to other countries more advanced than the Philippines on two main reasons

Firstly, the training that those specialists have acquired cannot be effectively utilized in our country. On the surface, our country does not have the instruments, facilities, and capital to harness their knowledge to the people's needs. In truth, such tools could be availed of and geared to the youth's programmes for acquisition of knowledge.

Secondly, because of the strong influence of our people's values pervading the subconscious, the Filipino tends to look down on a fellow Filipino as lower in category to a foreigner, specially Americans or Whites of the same profession even, if in truth of facts it is the reverse of the presumption. Such influence of age-old learning has compelled the Filipino to look towards the outside for anything from the search for a national language to the feeding of an infant.

Remember, we are like this because of our past. Remember, too, that the education of a people starts even centuries before they are born.

But as I said at the start, we are beginning. In the recent years, there have been many of our young flocking to our technological schools. Science consciousness is gradually starting to seep into the life-stream of the Filipino people. The government, although a low and typically bureaucratic, initiated moves to advance science and technology. I repeat, we are now beginning.

Investment in the Youth

Being aware that it is in the youth that the promise of tomorrow lies the Philippine government is now paying greater attention to science education and development for the youth Not only has the government of my country been vitalizing science teaching in our schools but it has begun to provide our young with out-of-school incentives for the science inclined. And one of the agencies established by the government to undertake the job of developing among the youth science awareness, as a positive factor for individual and national progress is the Science Foundation of the Philippines.

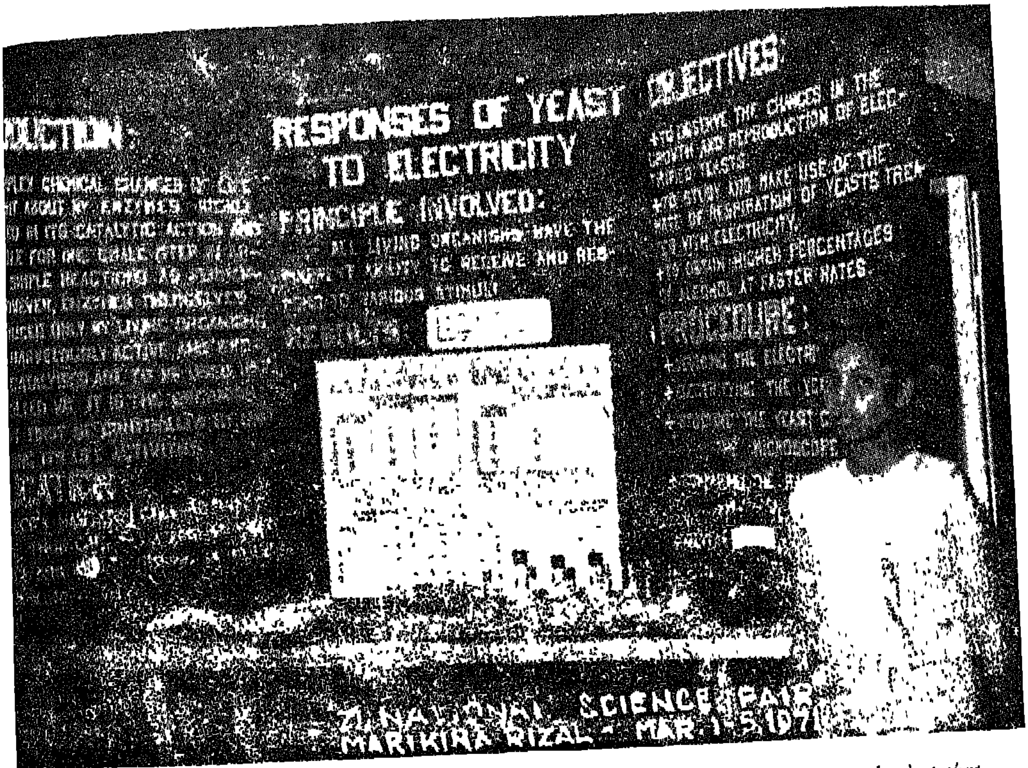
This agency, a quasi-public corporation, was created by law in 1952 under the then President Ramon Magsaysay. It has undergone several changes engaging in several activities or projects which were simply hitched on to projects of other government entities because it lacked funds for its own projects. Contributions and donations from the moneyed private sources did not come in as expected. It was kept going only by a handly of dedicated members of its Board of Trustees who among themselves looked for sponsors of young students' scholarships in local schools or abroad, work for the establishment of the Philippines Science High School founded by the government and inspired the government to established the National Development board.

However, now, the Science Foundation of the Philippines, since two years ago, has been granted a slice of the income of the government from a special science tax which in 1969 grossed a total of 40,000,000. According to the law governing this special science tax, 85% of the collection from this tax goes to the National Science Development Board, 10% goes to the National Research Council of the Philippines and 5% to the Science Foundation of the Philippines

The National Science Development Board deals with applied research and development projects and economic feasibility studies. It helps inventors and specialist-researchers not only financially but also with technical advice and guidance. The National Research Council of the Philippines supports programs and projects involving basic and functional researchers

Meanwhile, the Science Foundation of the Philippines is given the following functions:

1. To encourage, protect and aid in the organization of *science* clubs, *science and technology museums and science societies* in schools and colleges and enhance and promote science consciousness in the people;
2. To foster interchange of scientific information among scientists here and abroad,
3. To initiate, promote, stimulate, solicit, encourages, and support research studies in the promotion of science consciousness by means of grants, loans, and other forms of assistance to qualified persons and institutions applying for same;



Prize winning entry "Responses of Yeasts—its Electrone Irradiation by Grace Cid on the fact that electrifying yeasts under certain conditions results their greater fermenting ability".

4. To enhance out-of-school science activities among the youth; and
5. To act as science adviser to the National Science Development Board

Programme Goals of the Science Foundation of the Philippines

The SFP has the following programme goals in the promotion of science consciousness:

1. Establishment of 13 science regional centres for the whole country,
2. Acquisition of science films and establishment of a working film library;
3. Establishment of a science reference library in Manila and in the regional centres;
4. Establishment of a national science and technology museum and a modest museum of science and technology in each regional center;
5. Acquisition of mobile units for Manila and the regions; and
6. Organization of some 16,000 science clubs all over the country

Vehicles of Attaining Objectives

Actually the Science Foundation of the Philippines has for its backbone the science clubs it aims to organize and vitalize through

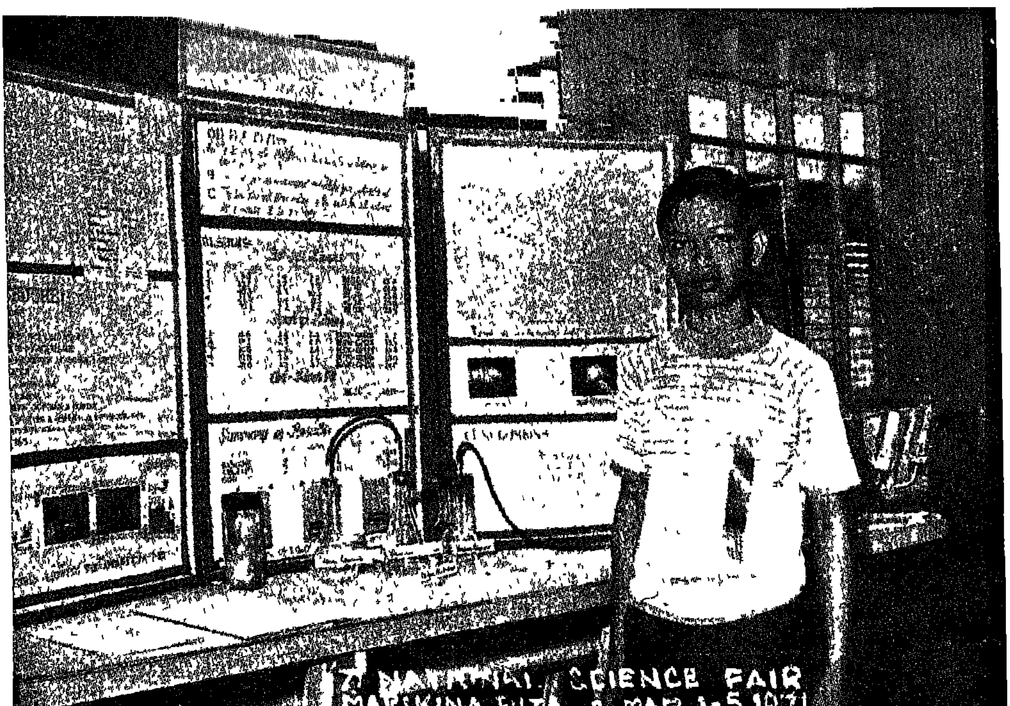
out the Philippines archipelago A string for these clubs composed of students and non-student youth from the cities to the barrios throughout the country could be the most effective dissemination of science consciousness among the people.

Regional Centres

Composed of more than 7,000 islands, big and small, the Philippines archipelago is divided into 65 provinces. The Science Foundation of the Philippines has divided the country into 13 regions with each region made up of three or more provinces and cities. Each region has its regional center under a Regional Science Promotion Officer (RSPO) The RSPO takes charge of the following activities and functions:

1. Organization of science clubs in the region and vitalizing and co-ordinating their activities;
2. Acting as liaison officer of the SFP in dealing with local school heads, government officials and civic-minded citizens who are directly or indirectly involved in the various activities of science clubs in the region such as science quizzes and fairs;
3. Maintaining the regional centre office and supervising its staff,
4. Setting up of a modest science film library, a reference library, a miniature science and technology museum,

Another Prize winning entry "The Vitamin A Content of Bangus and Apahap (Philippines fishes) Liver Oils" by Manolo Mena at the National Science Fair in the Philippines.



and a gadget shop which shall be open and available to science clubs and individual persons with interest in science; and

5. Operation of a science mobile unit—a transportation item with projectors and laboratory equipment and devices aimed at selling science to the people particularly those in rural areas

The SFP, however, has not organized six of the 13 regional centres and the understaffed central office has to enlist the services of its handful of employees to the unorganized regions to really make SFP activities in scope

The Science Film Library

The Science Foundation of the Philippines Science Film Library started from scratch. Through donations and purchases, the SFP has now in its possession some 200 reels of science films which are made available for loan to interested public and private schools, civic and scientific organizations or any purposive group or individual.

However, to date, the SFP neither has a film projector of its own (it borrows from other government agencies when need arises) nor has it a single mobile unit to bring these films to the remote area. If SFP films are shown at all in the provinces it is often done so by central offices personnel going there on workshop-seminar duties.

One film which is very popular among college students is the "Modern Chemistry" series consisting of 160 lessons of 30 minutes per showing. In 1962, the SFP succeeded in obtaining these and others from Asia Foundation. The SFP wanted to reach as many places as possible so that they may benefit others. Viewers found the lessons very effective in introducing new concepts in chemistry So the SFP initiated a television programme "Modern Chemistry on the Air", with the cooperation of the Bureau of Private Schools, several colleges and universities, two television manufacturing firms and a television broadcasting station

The Bureau of Private Schools approved the accreditation of one academic unit to students enrolled in basic chemistry at the scheduled time for the telecast of "Modern Chemistry on the Air". The involved colleges and universities scheduled chemistry classes at the precise time that the lessons went on the air Two big TV manufacturing companies loaned to the SFP so many TV receiving sets, which the SFP, in turn, lent to the enlisted colleges and universities for a minimum period of one semester A big TV broadcasting station telecast the chemistry lessons as a public service gesture.

The programme was successful. It went on for some time. But the films became scratched and blurred due to overruns and no replenishment came The programme folded up, yet, the SFP has proven that the *bayanihan* or cooperative spirit among our people is not dead and that there is the feasibility of concerted action in science promotion projects.

The SFP intended to revive the TV programme and branch out to other subject areas Perhaps it could popularize TV lessons on science and technology to a successful extent that the youth in their homes would wait with anxiety for the telecast as they do wait for telecasts of basketball games and pop-music-and-dance programmes.

At present, the SFP is engaged in a joint project with the Scientific Film Association of the Philippines (SFAP) in showing science films in the SFP regions. Called the "Scientific Film Forum" project involves the Science Club Advisers Organization of a region

which makes a request to the SFP for more information and educational aids on developments in science and technology.

Thus, in the regular meetings of the régional Science Club Advisers organizations, science films from the SFAP are shown and SFP science education experts act as moderators and resource persons during the open forum after each filming. The SFP also takes charge of the coordination work with the regional science clubs or projects—before each forum The SFAP supplies the projectors and other filming needs

Through these film forums, the SFP hopes to give science teachers more of what they could effectively impart not only to their students in the classrooms but also, or more so, to the members of their school science clubs.

The Science Reference Library

Dissemination promotion and application of the boon of science and technology on the people through books, magazines and periodicals is one of the aims of the SFP The agency is establishing in each regional centre a reference library which will specially deal with science and technology. Primary consideration is given to the acquisition of prescribed textbooks and adequate reference books used in the schools in the region to help meet one of the biggest needs of education in our country.

These regional reference libraries shall be opened to the science club members and advisers, and also to the people of the area with effective safeguards and regulations as to the manner of borrowing and returning, and loss of or damage to the library books or periodicals. Posters and film showings at the centre and other 'come-ons' may be resorted to by the RSPO to entice students and out-of-school youth to the center's reference library, as well as to its gadget shops and museum.

To achieve the objectives of the SFP in the establishment of these libraries, foreign assistance as well as local sources are tapped for donations, in kind or in cash.

The Science and Technology Museum

One of the most ambitious projects of the SFP is the establishment of a big and modern purely science and technology museum in Greater Manila, the building of which alone could cost no less than five million pesos This project is aimed at stimulating or awakening science consciousness among the people of the Philippines, especially among the impressive youth. The Ministerial Conference on the Application of Science and Technology in Asia (CAST-ASIA) held in August 1969, in New Delhi, amply discussed the need for establishing a science and technology museum in each developing country of Asia.

Plans for the Philippine Musuem on Science and Technology call for a big parking space so that cars and buses of the viewing public could comfortably and easily park. Therein, elevators and connecting bridges shall expedite movements of viewers from one section of displays to another for some three hours without fatigue.

Displays that more or less number up to 2,350 shall be solicited as donations from equipment and apparatus manufacturers but minus and advertising gimmickry beyond a nameplate identifying the donor

Museum displays shall not be static or cased in glass. All displays shall have *motion.* They shall be running or easily operated by spectators. Displayed views or stills shall at least be in dioramas to give the three dimensional effect to viewers.

Problem. Financing the museum, which

at the rate prices are soaring up, right amount to 20,000,000.

Suggested Solutions 1. A special tax law, the Science Tax Law, was passed by Congress and approved by the President. Five per cent of the collections under the law goes to the SFP. But this amounts only to a measly 2,000,000 annually with the bulk going to operating expenses and only 575,000 going to capital outlay, that is, in the designing and construction of the museum building

2 Request scientific and technological societies to help Some philanthropic Filipinos shall be requested, too, to finance some displays.

3. Collect a minimum amount for entrance fee.

4 Sell pamphlet guides that describe the scientific and technological displays. These pamphlets could be effective education aid.

5. A cafeteria or restaurant may be operated in the premises.

6 Make the buildings of the museum attractive enough for tourists, and students by having it as a beautiful architecture in itself, having it as the tallest or the sprawlings building either in Asia or in the country.

Again, as I said, we are only beginning, This national science and technology museum is still on paper—out of the drawing table but still a plan nevertheless

Besides, the national museum for science and technology, the SFP is also establishing science museums in minute form in the regional centre.

Problem. The SFP has no museologist in its personnel staff. This we hope to solve very soon.

Mobile Units

To solve the problem of distance and unavailability of transportation facilities that are persistent barriers to a nation's progress, the SFP plans to procure mobile units equipped with science kits and gadgets, audio-visual aids, and projector for showing scientific and popular films in order to facilitate the promotion of science in the remote areas of the country hardly reached by other science promotions media With these science mobile units operating in the hillside settlements swampland villages and sea coast barrios, the SFP hopes to awaken rural people to enormous possibilities of science and technology in improving their daily lives.

Problem. Cash again Our country is undergoing fiscal retrenchment and allocation for items as big as for mobile units are difficult to come by The SFP operates without a single official transportation facility.

Solution The SFP solves this problem by borrowing the facilities of other agencies like the Presidential Assistant on Community Development (PACD) in the regional areas. This, for the moment is only a stopgap measure. The SFP hopes to get some transportation units from Japan through the Reparations Commission or purchase one every fiscal year

The Science Clubs

Even before the Science Foundation of the Philippines was established or created by law, there have been science clubs in our schools. But these science clubs were mainly social if not political in nature. The science class, like biology or physics, form themselves into a club in order to elect their officers who in turn could be named delegates or representatives of the class to the science council or science congress After elections, the science club ceases to be and the aggruptation becomes a class in science pure and simple.

But these movements are not purely along the lines of science and technology and the activities of these organizations are not continuing but periodic So, the SFP saw it fit to formalize the organization of science clubs in 1967 It succeeded in organizing a handful of school science clubs in Manila and called it the Science Club of the Philippines, Chapter I. There was much hope and enthusiasm. SFP officials got invited to talk in school gatherings on the topic of organizing science clubs. But like our proverbial cogon grass, the club had a conflagrating ardor, it burned big and bright only to die at the end of a sigh

Post-mortem examination for the club could reveal death as caused by several forces One in non-continuity of administration and direction of the SFP For several years the SFP was practically a planning and formulating office composed of the Board of Trustees It had no staff of its own It simply suggested projects to the NSDB and the latter office implemented the plans. Later on, a couple of years ago, to be exact, a handful of men formed the SFP staff of casual employees and carried out its projects with the help and cooperation of NSDB cash and men. With a staff that was very much short of the needs of the project's assigned to it, the SFP could not help but fail.

Last year, the SFP had an administration officer and a personnel officer plus the chief of what was then the promotions division who in turn had three casual or contractual employees under her The science promotion division chief organized science clubs in their school. This was done in three pilot provinces of different classifications After the seminar, there was no follow-up due to lack of man or personnel.

It was like that when I entered the picture I was then head of an office of the NSDB in-charge of scholarship grants for under-graduate science and technology courses—the Science Talent Search (STS).

Organizing Science Clubs. Knowing fully well that science promotions can be best realized through the students who are young and with pliable minds and no longer bound by the chains of centuries old beliefs and superstitions—for they shall be the men of their own generations—the SFP has elected to spend almost all its efforts on science clubs dynamics Through science clubs, students with inclination in science may be given more challenges and better direction and development. Student members of the club can develop more systematic programme of activities which may lead to creativity and originality thus enhancing more interests in the various fields of science and technology. Besides, in science clubs, the individualistic attitudes of our youth could probably be reduced, if not eliminated by working cooperatively and harmoniously in club projects. This individualism has to go and be replaced by an involvement in scientific activities and events along with others With the help of zealous advisers, science club members could have better access to career information, better guidance on what profession to prusue in college and in the development of worthwhile in science and technology.

In a southern island province of the Archipelago, thee conomic programme co-ordinators utilized the science clubs in the province in typing the soils of the different sites in his province. He did it at a lesser time and with practically no cost for the provincial government in the task of taking soil samples done by science club members.

How the SFP Helps Organize Science Clubs. The SFP with the cooperation of

the Department of Education, encourages and spurs the organization of science clubs in schools. The first step is the holding of a national workshop-seminar in the 13 regions. A region is comprised of three or more provinces and the cities within the area. Science teachers in the public and private schools in a region, especially the science club advisers, are invited to join the workshop-seminar. Their transportation fare and board and lodging are taken care of or underwritten by the SFP. This year's topic in the workshop-seminar was "Organizing and Vitalizing Science Clubs."

No less than 80 science teachers and club advisers attended each of the seminar held in the regional centres of the country. These teachers, in turn, conducted each workshop-seminars in their respective school divisions. Teachers from schools with science clubs went home with more and better ideas on vitalizing their science clubs. Teachers coming from schools with no science club went home with ideas on effective ways of organizing science clubs of their own. And the teacher-participants in these seminars organized themselves into the region's science club advisers and science teacher-leaders organisation pledge to support SFP policies.

Science clubs are of many sizes, shapes and hues, so to say Sometimes, in a high school we have the following science clubs. general science club, biology club, chemistry club, physics club, math club, trigonometry club, natural club, and infinitum. Sometimes, each science class or section is formed into a science club. How does the SFP deal with these clubs?

The SFP is not particular about the number of science clubs, the size of membership or of what particular aspect of science the club deals on The aim of the SFP is to have one overall science club in each school in the country. It is with the school science club that the SFP deals through the school head. Eventually, the SFP works for the organization of four subsidiaries of the school club—the biology, chemistry, physics and mathematics clubs. The other clubs are allowed to go on operating at any rate

This is so, because the SFP is interested in dealing with all the clubs through these four subsidiaries, via the school science club for facility and concentration

What incentives does the SFP give to these science clubs?

Science Quizzes and Science Fairs

Every year the SFP sponsors through the science club advisers organization and the school science clubs, science quizzes and science fairs on regional and national levels. Last year, these contests were open to both secondary and college students. But to give it more impact the SFP is limiting competition this year to high school students only.

By January next year, these regional fair and quiz contests will take place simultaneously all over the country in sites picked up by the regional officers.

Contestants in the regional competitions are those officially declared winners in school level contests being held this month.

The Science Quiz Programme is used to project science and develop science consciousness not only in the participants but also among the attending audience. Public response to these quizzes is continuous and enthusiastic with national and local education authorities actively participaring in its planning, preparations and execution. Local civil authorities and civic organizations likewise, extend willing support to the quizzes

As in the past years, quizzes are parti-

cipated in by individual students in the subject area of their choice There used to be three subject-areas biology, chemistry and physics Now, to emphasize technology, mathematics has been added. A student can participate in only one subject-area. Sets of questions are written out and administered at a time

However, the SFP plans to change the rules of the quiz competition next school year by having a team of four science club members (each team may have alternates) who will answer written and oral questions during the quiz—as a team and not as individuals This is to emphasize not only mental alertness but also the ability to work as members of a team

The SFP is working on the plan to have a private firm or firms to sponsor the contests and underwrite most of its financial needs Several companies have responded favourably to such a request from the SFP.

Science Fairs provide unlimited opportunities for students' creative talents, promote science consciousness not only among students and teachers but also among the public in general. They are effective ways of popularizing science and technology through purposive applications of the theories into practical inventions, researches, and studies

The Science Fair offers two areas of competition: one, the *physical* and the other, the *biological*. These fairs encourage students to undertake experiments and execute projects using their own initiative, imagination and analytical thinking The prepartion of a project by science club members give opportunities for group work in pooling their ideas and resources to achieve a scientific goal Thus, these exhibits could be expressive of individual or group work

Handsome cash prizes and plaques, medals and certificates are given to the winning contestants in both science quizzes and science fairs

Youth Science Congress

Another activity which is planned to be undertaken by the SFP annually is the Youth Science Congress, a jamboree of selected and outstanding science club members, science club advisers and school administrators and government officials

But before the jamboree or congress in May 1971 the SFP will sponsor a symposium on *science club problems and solutions* to be participated by officers of the regional Science Club Advisers organizations and the school heads and administrators

Here, problems of science club and science club advisers on one hand and school heads and administrators on the other shall be intelligently discussed and proper solutions thereto advanced by both for common agreement

Science club advisers organization representatives or delegates will subsequently go to the congress of science club members with data on science club and advisers and school heads and administrators' differences and entents Thus, in the course of talks and discussions on problems of science club members during the Youth Science Congress, they can have point to start from and a corresponding point to arrive at.

In the Congress, science club members and advisers will discuss their common problems and arrive at the proper solutions for them. They will also discuss feasible investigatory projects and plan out science club activities for the next school year.

Thus, the young science potentials of the country pool their heads together to indirectly plan out a big portion of their country's future.

It is also planned, that every year the SFP will choose 10 outstanding high school

students in science—one each for the following subject-areas: (1) general science, (2) general science, (3) biology, (4) chemistry, (5) physics, (6) arithmetic, (7) elementary algebra, (8) advance algebra, (9) geometry, and (10) trigonometry

The announcement and public presentation of these 10 outstanding students, who, shall be named as delegates to the Youth Congress will be done during the Congress in a simple but formally impressive ceremony where prizes and awards will be given to them. Aim in selecting the 10 outstanding science students is again the development of love for science activities among the students of the country. For two of the prerequisites for choice or nomination to the award are high academic grades in science and mathematics and active participation in science club activities.

Conclusion

Thus, I repeat that we are beginning to enter a new dimension in science education outside the school room through out science clubs. Through these clubs, we hope and expect to fashion out of our youths today a new Filipino generation for tomorrow—independent, self-reliant and disciplined; open minded, confident, courageous; no longer with narrow, selfish and parochial views but nationalistic and involved, proud of their own work, their own creation, their own achievement.

Participants in the Campus Science Writing Seminar held on 23-27 March 1971 in Bacolod city, A pilot project aimed to train high school and college writers in science writing.

Today, our youth are getting imbued with this spirit, this irreverance to tradition, this disrespect to the tried—and true—even with the meager science education they have imbided. Through the science clubs, the SFP is encouraging this rebirth of the noble Filipino spirit, the youth's desire to discover their potentials, the restiveness and dissatisfaction with the old mould, the pattern of creativeness and originality, the urge to break away from old moorings— of all which the Filipino youth could qualify.

Today, Filipino are beginning to flock to technology schools. Agriculture is no longer regarded as demeaning or degrading. We are producing more and better crops through our local green revolution being initiated by our new and much younger and educated crops of farmers.

We have engineers and our science schools have become tremendously presti-geous or popular.

Through a close relationship with our Department of Education and our National Manpower and Youth Council, the SFP is helping direct our youth towards a pur-posive future through science club pro-grammed activities.

Participation of Young People in Programming and Conducting Extra-Scholastic Activities in U.S.S.R.

S. PARAMONOVI
U.S.S.R

PARTICIPATION of young people in scientific and technical creative efforts today, has assumed a massive, organised and purposeful nature

The transition in the Soviet Union to universal secondary 10-year schooling is accompanied by the increase in the role of school in communist construction Particular attention is paid today to the necessity of the secondary education reflecting the demands of development of modern science, engineering and culture. In this connection the schools of the Soviet Union have adopted new curricula.

On the contemporary stage of development of socialist society one should not only see what the individuality of new man is to be like, but also should clearly see, by which ways and means it could be achieved.

Paper presented at Unesco Regional Seminar for the Leaders of Youth Science Activities, New Delhi, from 14 to 18 December 1970

Therefore the efforts of experts working in diverse branches of science are actively directed at achieving a more thorough understanding of man's nature, the nature of a child and an adolescent, and of their relations with modern society, as well as at searching for ways of increasing the effectiveness of all the factors in the upbringing of man, significant in forming his nature.

The prophetical words of Karl Marx are well known, to the effect that with the substitution of communist relations for capitalist ones the wealth of society will be measured by the amount of man's leisure, but not working time, that is, of the time he will be using to restore his physical and moral energy and to improve his knowledge and abilities, as well as for his moral perfection Rational utilization of leisure time by working people is a most important task, and the school is to play quite a significant role in fulfilling this task While rationally organising the school pupils' activities in their leisure time and inculcating in them the habits of a cultural organisation of their leisure activities, we not only increase the effectiveness of the process of upbringing children at school, but also create the necessary prerequisites for the process of all-round development of man's individuality to be most productive in his mature years, that is, when he will be independently organising the process of his relations with other people, as well as with the world of science, arts, and culture, with nature, and with his environment.

However, self-education can be guided: We cannot be indifferent as to the direction that process takes, or to its results. So how is interconnection of the child's upbringing at school and outside it to be guaranteed, that is, the upbringing by the school

and the family, by the teacher, the parents, and the society

In the first place, the period of upbringing under the guidance of teachers should be prolonged.

It is this very demand that has entailed the setting up in the Soviet Union of boarding schools, schools and classes of longer school-day, Young Pioneer and other camps, and of quite a network of extra-scholastic establishments. With this aim in view we are also searching for various forms of organisation of work among pupils at or near their home.

The problem of organising extra-curricular activities of children, far from being a new one, has been of interest to progressive pedagogues for a long time Ushinsky, the famous pedagogue of old time, wrote more than a century ago, that if man does not know what to do throughout the day, his head, and heart, and moral are spoilt.

Maxim Gorky, a great writer of our epoch, as if developing the same thought, said that a day should be viewed as a small life, and therefore one should check up, what that small life abounds in

It depends on the teacher to a great extent, what the pupil will do in his spare time: will he do something useful for himself, for his friends and for society, or will he be looking for dubious entertainment.

It is quite well known that whenever the child or adolescent has found an activity of personal interest to him, his knowledge grown deeper, and creative activity is intensified. School children acquire even new interest in knowledge, science and books, while fulfilling diverse tasks set before them by reserarch institutes and other establishments, while compiling soil maps, solving difficult problems, working on technical innovations, taking part in hiking tours to study the history of native region, and participating in sports competitions and amateur art circles.

Pupils gain vast knowledge in literature, history, mathematics and biology while working at various clubs and societies, taking part in disputes and discussions, in the work of political circles and theoretical seminars, as well as in the process of experimental work; many work habits are acquired while engaged in activities of social utility at pupils Production Teams, at school workshops, etc.

With the significant aim in view of developing the interests and abilities of school children, optional courses were introduced at schools throughout the Soviet Union.

The optional courses being not obligatory, their programmes could be either connected, or could have nothing to do with the curriculum; they could be devoted to mathematics and computers radio and electricity, biology, agrobiology, chemistry and technology, or to music, literature and the arts. However, no matter what the subject of the course, it broadens and deepens the knowledge of the pupils, and to a certain extent helps them choose their path in life, and their future profession

Pupils spend at school not more than 25 to 30 hours a week, the rest of the time belonging to out-of-school activities, to one's hobby and being their leisure time.

Out-of-school activities are organised on a voluntary basis. The law at school is as follows: you must, you should—the pupil has to be at school on time whether he likes it or not, he must do the homework whether he wants or not. The out-of-school activities being organised on a voluntary basis, the pupil will attend the sessions of his circle if he like his work there, but if he does not, then he won't, and nobody would force him to. Therefore it is necesary for extra-scholastic activities to be only

meaningful, but by all means absorbing, and imbued with the spirit of interesting inventures, and creative spirit.

The main directions in such work should be experimenting, searching, designing, inventing, and doing research.

In recent years the extra-curricular work among pupils has grown more massive, diverse, and has over-stepped the limits of both school and even out-of-school establishments.

Circles have been substituted by specialized clubs, pupil's scientific societies, museums, and lecture halls.

The pupils who possess particular liking for engineering are visiting and studying at plant designing bureaus and research institutes, and conducting research work within their ability.

Instead of the literature and drama circles of the past, with their small number of members, new creative literary societies of school pupils have been set up, as well as youth amateur theatres.

Hiking tours to an ever greater extent assume the character of scientific expeditions, fulfilling the tasks set by geological departments, museums of history, and research institutes.

The results obtained by pupils after experimenting on school plots of land are widely used in agriculture, while geological groups are sent to stap natural resources, discovered by young geologists.

Senior from pupils themselves are equipping modern study rooms at their school with the latest instruments and teaching aids, and are assisting enterprises and collective farms in their work and in assisting enterprises and collective farms in their work and in fulfilling state planned quotas.

The task today is to facilitate the work of technical and scientific circles, sections, clubs and societies for all school pupils, and not only for those new chosen, gifted children and adolescents. Our schools see their aim not only in giving their pupils a good education, but also to inculcate in them an enthusiastic attitude to a branch of knowledge, and an interest in the process of technical creation.

We do not think that all of them will become scientists or designers. We are sure however, that in our time any job should be approached from positions of an innovator or researcher.

School pupils are reaching out for modern engineering. The engineering of yesterday just won't do for them. So it is not accidental that most popular among them are the circles of radio fans, automation, cybernetics, and others, having to do with the latest achievements in science and engineering. As a rule, there are circles at every school, but one single school cannot always comply with all the requests of its pupils. In such cases several schools pool their efforts, and set up the societies of young mathematicians, physicists, chemists, or various scientific associations of pupils, and technical circles.

Ever more often Soviet pupils are conduct in their extra-scholastic activities at different enterprises, laboratories, research institutes, establishments, higher educational institutions, or cultural establishments, with scientists, engineers, technicians, and figures in the field of culture and arts taking part. Schools of young mathematicians, physicists, chemists, biologists, and children's sports schools are functioning successfully at many colleges.

Thus, in the city of Urkutsk the Znaniye, or knowledge, City Pupil's Society has been active since 1963 when it was set up. It has 22 sections with 1600 schools pupils attending. The diversity of the pupils interests is reflected in the very list of the sec-

tions. the astronomy section, those of physics and mathematics, medicine, law, history and local lore, and others.

The section of medicine functions at the chairs and clinics of the Medical Institute and other health establishments; the astronomical section is working at the planetarium; the archeology section—at the Local Lore Museum; that of international affairs—at the Political Education House, the section of literature and journalism—at the University and at the editorial board of the *Sovetskaya Molodyozh* (or Soviet Youth) periodical; the law section is functioning at the law chair in the University; the geography section—at the Geography Institute of the Soviet Academy of Sciences; the pedagogical section—at the Pedagogical Institute; and so on.

Leading scientists of the Institutes of East Siberian Branch of the Academy of Sciences of the USSR and of other research institutions are taking part in the work of the sections, and are guiding the pupil's activities.

More than a thousand scientists, engineers, and specialists in the most diverse fields of knowldge are participating in the Society's work in their spare time, getting no remuneration for that.

In the industrial city of Chelyabinsk such work of pupils in the field of engineering is a significant factor in preparing the children and adolescents for their participation in the progress of science and engineering.

Very interesting is the work of primary technical modelling circles, united in the Club names Shouroup (or Screw). Members of the Club, pupils of 7 to 10 years of age, are mastering the elements of engineering, and acquire the habits they will need when working at the middle and senior stage technical circles. Attention in technical circles is focussed on the development of designing habit in the pupils

A Pupil's Scientific Society is also functioning here. It has 32 sections and groups whose working is guided by more than 100 scientists, college instructors, researchers and the best teachers of Chelyabinsk, with Dr. Rakov, Pro-Rector for Science of the City Pedagogical Institute.

Many achievements of young researchers are of significant theoretical and practical interest. Thus, the chemistry section members have elaborated technological Processes and methods of obtaining much needed chemical agents, and established the law of action of new metal corrosion indicators; both are now made use of in industry.

The young chemists of School No. 92 in the city of Chelyabinsk have conducted systematic analyses of water in the Miass river and in Lake Smolino for the level of population, and have helped the "Solnechny' and "Lazurny" state farms by making an analysis of their soil and drawing soil maps of their fields.

The young biologists of School No. 108 in the city took part in the work of the Chelyabinsk Fruit and Vegatable Station named after Ivan Michurin, and studied the local distribution of the various sorts of apple and pear trees for the Chelyabinsk Region in connection with the development of fruit growing in the South of the Urals. They have also analysed the chemical composition of apples and pears, grown in one and the same year.

Arrangement of Science Days for school pupils with participation of scientists is an effective method of promoting the development of the urge to acquire more knowledge in the pupils, this is also achieved through setting up branches of every section of the City Pupils' Scientific Society at the schools in the city and throughout

the Region, which broadens the scope of its activities, besides. There are 12 branches functioning today at Pupils' Scientific Societies.

The Pupil's Scientific Society enables the pupil both to master the extra-curricular material, and trains him or her to be an active populariser of science; it involves the senior formers in research work and invention contributes to their getting acquainted with available ways and methods of research; kindles the interest in reading specialized books on a certain subject; and teaches the pupil the methods of independent work with literature.

Over a period of seven years the Society members' have conducted more than 500 works under the guidance of scientists. Part of the works have been published in three issues of *Yuni Issledovatel* (or Young Researcher), in the *Khimiya i Zhizn* magzine (or Chemistry and life), and in other periodicals

Eighty-one per cent of Society members choose professions later on, closely connected with their field of work at the Society. Having started their studies at a college or their work at an enterprise, they join Student Scientific Societies, make innovations and inventions

The character of work of the Minor Academy of Sciences "Iskatel" (or Seeker) in the Crimea is similar to that just described There are 20 sections with about 600 members. All in all, beside the Minor Academy members and candidates, 4500 pupils are taking part in the work of the sections. The name of the society—the Minor Academy of Science-impresses the children and adolescents who are in need of a game where they could pose as grown-ups.

The Minor Academy of Sciences has the sections of mathematics, physics, cybernetics, astronomy, chemistry, biology, history, and local lore, engineering, and a press centre.

Every section has its branches in the cities, towns and villages in the Crimea· in Kerch, Sudak, Yvepatoriya, Yalta, and others.

The pupils themselves award the titles of Minor Academy Member or Candidate, the demands being very exacting. Thus, out of the 150 pupils regularly working at the cybernetics section in the town of Simferpol, only 7 are members, and 9 Candidates of the Minor Academy of Science (or MAS)

To be awarded the title of MAS Candidate, and later on its member the pupil must work at the circle or society and have his or her original works, their nature depending on the section; the works can be practical in the biology section (observation of animals, experiments with plants), while only those pupils who have scored successes in mathematics olympaids could be awarded the Candidate or Member titles by the mathematics section (3 times 3rd place, or twice 2nd place, or one 1st place).

As a rule, MAS members are authors of original works. In the years the MAS has been in existence, the MAS members working in the cybernetics and astronomy sections alone have published more than 20 scientific works. The Iskatel Minor Academy of Sciences in the Crimea for the past two years has been taking part in the annual intercollege Students', Conference and several works by MAS members have been reported at Republican Conferences.

The best works by MAS members are presented at Republican and All-Union Exhibitions.

In recent years the MAS Iskatel has been awarded with 29 Medals of the Soviet Economic Achievements Exhibition and with

a great number of Diplomas at various other Exhibitions.

Nearly 300 young astronomers are conducting a very serious and responsible work; thus for instance, they have taken part in meteorite observations within the framework of the programme of the International Quiet Sun Year. They have registered about thirty thousand meteorites. Besides, they conduct observations of planets under the guidance of Professor Prokofyev of the Crimean Astrophysics Observatory.

The Minor Academy of Sciences was the first to organise on a systematic basis the acquaintance of pupils with the ideas and apparatus of cybernetics in accordance with the plane elaborated by the Young Researchers' Council of the Cybernetics Institute of the Academy of Sciences of the Ukraine, with due regard to the necessity of more thorough studying of certain subjects in the school curricula for mathematics, physics and electro-engineering.

Good training promotes the broadening of the scale of technical innovations and modelling by the pupils in the field of cybernetics. More than 400 pupils have studied at the cybernetics school.

The MAS Council has announced admission to its Correspondence School for Young Cybernetics Fans in the Crimea. More than 120 applications have been received up to date.

The MAS cybernetics section members have recently designed and made various installations, automats and models, and among them the "Kostyor" and "Iskra" (or Campfire and Spark) computers, the playing automats "Mouse in Labyrinth" "Examiners", "Coaches"; a large set of visual aids instruments producing models of behaviouristic traits of live organisers, and teaching automats

The MAS cybernetics section has aroused interest both in the Soviet Union and abroad. The book *The ABC of Cybernetics* by Kasatkin, published by the Moladaya Gvardia (or Young Guard) in 1969, was a year later published in Tokyo in a large number of copies, and is to come off the press soon in Bulgaria.

The biologists in the town of Fedosia are fulfilling the request of the Institute of Southern Seas' Biology, studying the species of fishes in the Black Sea, and the biology of delphins.

Local Lore fans, working for 2 months that past summer under the guidance of the researchers of the Archaeology Institute of the Ukrainian Academy of Sciences and of the Khersones Museum, have been conducting excavations of the outskirts of Sebastopol, on the former site of Khersones, an ancient town They excavated a 3-metre layer of earth on a territory of 800 square metres, having found 7 ancient interments with various articles and coins, they have obtained quite a collection of amphoras and other vessels, a Greek inscription on a marble slab was excavated, as well as reliefs of the ancient Greek God Dionisus.

Academician Kolmogorov visited the mathematics section in January 1969. He met MAS members and candidates the best mathematicians from the school of the Crimean Region. Thus the meeting became another session of the mathematics section, with Academician Kolmogorov delivering several lectures, conducting a talk concerning the profession of mathematician, and answered the pupils' questions.

It should be mentioned while on the subject, that the members of the section are as a rule admitted to the physics and mathematics departments of the best higher educational establishments in the Soviet Union, and are studying there successfully

Pupil's Designing Bureaus are functioning in many schools in the country The town of Magadan alone has such Bureaus at 18 schools

Engineer-technologist Nefyodov heads the school' Designing Bureau at School No. 1. The school workshop has 23 metal-processing machine-tools, of which many were presented to the School by various enterprises, then were modernized by the pupils themselves, and are now successfully used.

The pupils have designed and built metal-processing machine-tools for electrotempering and, on that basis, electroacoustic ones, as well as spot welding apparatus, and a cam gear press for cutting out washers, and bending hinges for school desks.

The experience of School No. 94 in the city of Ufa shows that a vast assistance can be given to school by its pupils' parents, and how much can be achieved if the efforts are pooled of the teachers, pupils, and the parents of pupils.

The total number of pupils at the school being about 2000, there are 1700 members of the 100 circles Seventy-two teachers, 30 parents, and 30 senior from pupils are guiding the work of the circles at the school.

Naturally the entire extras cholastic work of children and young people is inconceivable without the participation and guidance of teachers and instructors, scientists, the pupils' parents, and the public in general

Thus, the Headquarters from Scientific and Technical Youth Activities has been set up at the Central Committee of the All-Union Leninist Young Communist League, with the aim of popularisation and development of children's technical creative abilities. Annual All-Union Exhibitions are held, whose motto is Young Creators and Seekers. The best works in all fields of science and engineering earn for their authors gold medals, and are exhibited at the Soviet Economic Achievements Exhibition in Moscow

In 1969 and 1970 an All-Union Competition was held, called "Created by the Youth". It was organised by the All-Union Trade Union Council, the Central Committee of the Leninist Young Communist League, and the Ministries of Culture and Education of the USSR

The competition was aimed at: (1) increasing the Young Pioneers' and pupils' urge to obtain knowledge about the breakthroughs and achievements in the contemporary science and engineering, culture and the arts, developing the children's and adolescents' abilities, and (2) broadening the network of technical and other circles, creative clubs, perfecting both the forms and purpose of the scientific and technical work among children, increasing its public use, better preparing pupils for their independent working life, and inculcate in them a creative attitude to acquisition of knowledge.

The winners of the competition are to take part in the All-Union Exhibition "Created by the Youth" in Moscow, at the Soviet Economic Achievements Exhibition in Moscow they will be awarded special Diplomas, and Medals "To Winners in Competition" 'Created by the Youth'.

For the young people interested in the latest achievements in the fields of science, engineering, electronics and radio-electronics, cybernetics, chemistry, biology, and the other, various technical magazines are published in the Soviet Union, such as "Modelist Konstrucktor" or Model Designer, "Tekhnika Moladyozhi" or Engineering for youth, "Young Teknik" or Young Technician, a library for those who do it themselves, "Znaniya-Sila" or Knowledge Is Power, "Radio", "Quant", "Nauka i Zhizn"

or Science and life, and so on. Young Technicians' Stations have been set up in all cities and central towns of Regions in the Country.

Future grows out of the children of today, it lives as the natural continuation of the present, just like the present has grown out of the past.

We are getting ready for the future, since we will be its masters.

Some Suggested Out-of-School Science Activities

Science Clubs

In a great number of developing countries, Science Clubs appear as being the major method used for the development of out-of-school science activities. In this way, for Latin America, according to a statement for ten countries, science clubs exist in eight countries, and there is a project in a ninth one.

The *purposes* of the science clubs are to draw the youth's interest for science; to increase their capacity, at the primary and secondary level, to learn the scientific matters which are taught; to make the youth more familiar with the laboratory words and to give them the opportunity to achieve, among others, biological, chemical and physical experiments, to give them the opportunity to learn by themselves, to develop their experimental capacities and skills to explore their vocations, capacities and originalities; to direct the young people to their university to technical vocation; and to help them to have a better understanding of science, of the place it has in modern life and of its influence on the development of the country.

From the first years of teaching, it may be thought of having the youth participate in out-of-school activities, because at the primary level, at the age of observation, it is useful to valorize their curiosity.

At the higher secondary level, (grammar schools) and colleges the young people must define their future career, and in this way, the out-of-school activities are particularly important for them.

For those who want to go on in university, it is useful to know what is done in the universities, and to have contacts with their teachers. For this category of young people, the science club must allow to achieve experiments on a higher degree, to learn to express themselves properly in scientific terms, and to present a work in public.

In the developing countries, the science clubs are organized under different forms and generally remain linked to the school or group which constituted them.

For instance, in Bolivia, there is, among others, a Science Club at La Paz, of which the *Colegio Evangelico Metodistdel Instituto Americano* is responsible, and at Cochabamba, the *Centro Experimental sky Pilots* (CESP), private institution devoted to out-of-school science activities, whereas in Peru the *Club de Ciencias del Instituto Pedagogico Nacional de Varones* is specialized in biology and chemistry, and that in Venezuela, the *Sociedad de Ciencias Naturales La Salle* is concerned with natural sciences, and the

Associacion de Estudiantes de Ciencias Luis Pasteur with microbiology.

All the young people, interested in science, can become members of those clubs. Generally, a teacher in science is appointed to organize and manage the club and to orientate the works. In order to give them the opportunity to show their sense of responsibility, the young people participate in the direction of the club.

In this way for instance, in the Republic of Rwanda, participation of young people in the activities of *Jeunes-Science du Rwanda* is guaranteed in the following way a leader (specialist) presents a programme of activities, the young people discuss the project, sometimes and some items, and define the order of priority. The achievement of the project is made by the young people under the direction of the leader(s).

This problem of participation has already been studied by ICC under the title: "Participation of young people in the planning and achievement of youth out-of-school science activities".

It may be thought of the creation either of a 'general club', which covers various science fields; however the members may be into working groups (e.g., physics, chemistry, biology, astronomy or of a 'specialized club' with a determined programme in a particular field. The specialization of the club, makes, to some extent its organization and the possible equipment of the laboratory easier, and precises the work of the leader

The *Mouvement Jeunes-Science* of Tunis is an example of 'general club'. In its central office at Tunis, it has, principally, a room for chemistry, one for natural sciences, one for physics-electronics, one work-room for mechanics and two collection halls.

We can mention a few, examples of 'specialized clubs': for Brazil the *Club Campo Belo* at Sao Paulo, specialized in mineralogy; the *Club Fiil* at Sao Paulo, for animal psychology, the *Centro de pesquisa espacial* at Fortaleza, for space research

At the primary level, the activities of the club are basically experimental. Their purpose is to teach young people to discover. At the lower secondary level (from 12 to 16) young people start with the systematical study of sciences, it seems to be useful to bring a supplement to the thoretical teaching. The activities which are adopted involve the visit of science museums; planetariums,.. . , and science camps (for the study of geography, geology, ...).

The interest of the young people is created by discussions, debates, competitions, interschool meetings, conferences and lectures, interschool science fairs, the publishing of information and science bulletins, visits of concerns with science interest, science films, works with "kits" and sometimes their manufacture, the manufacture of models and science devices.

As to the orientation of the programme of the club, the *Mouvement Jeunes-Science de Tunisie* is an interesting example. For this club, the works are classified into three groups.

Easy works, the originality of which will interest young people;

Specialized works (photomicrography, polarizing, microscope etc.,)

Important works wanting and thorough study and the cooperation of lecturers and specialists, teachers and technicians during a long period.

A non exhaustive list of themes is set up and submitted to the Scientific Council, For instance, in 1968, it contained: the study of building materials fatigue and of the corrosion; the study of quarries and mate-

rials the establishment of geological maps, the introduction to petrography, the sea currents, the under ground watercourses fishing and the seasonal migrations of fish; the problem of water, the problem of afforestation, soil formation, parasitology and biological struggle, various agricultural problems.

In electronics, by practical works, the young people are initiated to theory and technology A progression is always adopted for the achievement of the first initiation periods, theoretical presentation, function of components, setting up of diagrams, realization of various circuits, experiments and measurements, setting up of circuits. During the first steps of initiation, works were made such as the study and the assembling of a television set of a transceiver.

But in numerous countries, the long-term success of the science clubs largely depends on the financial resources, the laboratory equipments, the available place, the leaders' initiative.

If, at the primary education level, a simple room without equipment and a few "kits' already enable an interesting work, if only visits of natural sites can improve the knowledge (analysis of trees, animals, .) on the contrary, at the higher levels, a more elaborate equipment is often necessary

An interesting solution of this problem seems to us to be the one adopted in India, where 'Science Centres' Put at the clubs' disposal *scientific equipments* for demonstration.

Ghana, Rwanda and Senegal have underlined *the insufficiency of the full-time available rooms.*

Another problem of the developing countries consists in having the *themes of projects* for the science activities in the clubs.

Indeed, if numerous young people have capacities to work and to carry out a scientific projects, it is not always easy for them to find subjects of studies. So, one has to suggest them ideas and to see to give them a sufficient knowledge of the object of the proposed work a certain harmonization between the school and out-of-school activities can be profitable in that way

The planning of the two education systems should also take into account the national economic priorities and allow the young people to participate actively in the scientific evolution of their society.

In India, at the primary education level, "science consultants" visit the primary schools and organize meetings of teachers with a view to exchange ideas on the methods of science teaching and to advise the realization of some experiments. Science Lectures for primary school teachers are periodically organized on a regional basis, as well as science camps at the district level.

That system of 'science consultants' joins the ICC proposal to institutionalize the training and the exchanges of leaders for scientific initiation, in order that the normal working of the clubs do not depend upon the abilities of temporary leaders

As one must assure a certain permanence of the school staff, *one should assure a greater permanence of the responsible staff for out-of-school activities.*

Science Competitions and Science Fairs

In most of the developing countries, science competitions and science fairs are organized in order to promote the interest of youth for science by bringing them an additional motivation.

According to a statement made for 10 Latin-American countries, it appears that science exhibitions are organized in all

those countries. Brazil also organizes science congresses of young people. Science olympiads devoted to mathematics, and sometimes to biology, are held in 6 countries.

The science clubs or school teachers take generally the initiative to organize a science fair, considering the interest to encourage youth to undertake the realization of projects to be presented to the public, the patronage of those events being assured by various institutions.

For instance, in Argentina, in 1969, the *Segunda Feria de la Capital Federal* (Second Science Fair of the Federal Capital) was organized by the *Escula National de Comercio NO_3 Hipolito Vieytes*, under the auspices of the *Secretaria de Estado de Culturay Education*, and the *Terceria Feria National de Ciencias* (Third National Science Fair) was organized in Cordoba by the *Institute de Mathematica, Astronomia y Fisca* of the National University of Cordoba, under the auspices of the *Instituto National para el Mejoramienti de la Ensenaza de las Ciencias*, of the *Administraction Nacional de Education Media y Superior*, of the *Consejo National de Education Technical* and, of the *Superintendencia National de Ensenanza Privada.*,

In Bolivia, in 1968, the *Feria de Ciencias de La Paz* (Science Fair of La Paz) was organized. Thanks to the patronage of the *Centro Renovador de la Ensenanza de la Matematica*, of the *Centro Experimental Sky Pilots*, of the *Federacion Departmental de Maestros* of the *Instituto Americano* and of the *Colegio Nacional de Calacoto*.

In Singapore, in 1969, the Science Teachers' Association of Singapore took the initiative to organize a science fair.

This method consists in an exhibition of science projects realized by the pupils of primary and secondary schools. Those pupils explain to the public the fundamental points of their work and show the devices and main elements of their experiments as well as boards with diagrams and conclusions. According to the regulations each project may be achieved by one pupil or by a group of pupils

Most of the time the projects are presented in such a way that they can be understood by the non-initiated. They are judged by teachers, the appreciation of the works being based first upon the quality of the work realized and upon the understanding acquired by the pupil on the theme; one will be more generally interested by the original idea and the creative thinking than by the visual presentation and by details of completion.

The organizing council awards the winners' work. (This is an example of project of distribution of points; creative activity, 30 points, scientific thought: 30 points, thoroughness: 10 points, skill: 10 points, clarity: 10 points, interest of the public. 10 points—total · 100 points.)

These science fairs aim, among others, at giving the possibility to young people to acquire the confidence in their own achievements, having clever suppositions, programming the experiments, formulating and estimating hypothesis, communicating clearly and discussing their ideas

The Public Exhibition of the Works is the top event of every educative process. However, it is not an end, but a means that obliges all the candidates to make concrete work and to polish the details in order to be able to present it at a fixed date.

It stimulates the interest for science by an individual initiative, the student choosing the subject best adapted to his scientific interests. So, the young people are aware of the problems and rewards of the scientific research, and acquire a new respect

of the exactness and relativity of the results.

What is important for the developing countries, is that the young authority are not only valorized to the education institutions, but also to the national as well as international community. The winners may sometimes receive scholarships to go abroad. Moreover, the young people have the opportunity of contacting national or foreign science personalities and other foreign students.

Finally, essential point for their social role in the developing countries, they also directly participate in the diffusion of the scientific future of their country.

Considering the proposed objectives, it may be thought that the work must be experimental on a theme that enables the young people to learn by himself. The attention is also drawn on the method of investigation and systematization to acquire in order to realize those experiments

It is noticed that the works presented in the science fairs of the developing countries are varied, the subjects concerning specialities such as astronomy, anthropology, biology, physics, chemistry, pure and applied mathematics, technology,. .

The young people present not only theoretical projects (e.g., the applications of Boole's algebra), but also *projects directly related to the realities of social and economic development* (e g., comparison of the growth of food plants in various soils).

We think it extremely useful to realize a publication giving the titles of the subjects that have already been studied by thousands of young people during these last years. This would be a source of inspiration for young people deeply interested in science and technology.

The preparation of the project is made during the leisure time, outside the school hours. That preparation, however, cannot be an obstacle to the normal development of the studies, either interrupt the school tasks (except during the interregional or national fairs).

In order to be allowed to participate in a local exhibition, the author of a work contacts his teacher in science who transmits the registration to the organizers.

The role of the science teachers is essential for that type of out-of-school activities. That teacher will encourage his students, to start works, will raise their enthusiasm and their curiosity, and will be their guide, an adviser, but never their assistant. He will have to promote the relization of a school fair in his city and bring his support to other colleagues to form the organizing commission. In several documents received from the developing countries, it is underlined that the teacher may not help directly to the realization of projects, but on the contrary, he may suggest subjects of projects, discuss the qualities and deficiences of the project, suggest modifications in the sense of being a collective task and which characterizes the scientific attitude

The science fairs are organized at various levels, i e , the local, regional, interregional, national and international fairs.

The local exhibition is the easiest to organize. However, for the developing countries, it plays a very important social role, for, thanks to family links, it allows the establishment of the contact with the parents and the stimulation of the interest for science. So, *the young people participate directly in the diffusion of the scientific mind in their social environment* and if we take the case of the rural environment, they can, among others, contribute to the initiation

of adults to modern techniques of agriculture and breeding.

Concerning the other types of fairs and competitions, (science talent search), the very principle of 'selection' of candidates confers to these activities a more 'individualist' objective aiming more at the scientific development of the young man, in its proper particularity, the general objective being the detection of young talents, the formation of a scientific elite.

It is also necessary to assure a sufficient *publicity* to those out-of-school science competitions, and science fairs (by the radio, the television, the press, etc.), in order to inform the public of the existence and the possibilities of out-of-school science activities, to interest the parents in the works of youth, to promote the recognition of the young winners.

CAMPS AND SCIENCE COURSES

Camps, tented or permanent, are mainly organized to teach application of science to nature, and to acquaint participants with general ecology of the particular region and the place of theirs peciality within it: botany, zoology, physics, geography, anthropogeography (sociology), geology, meteorology, chemistry

Themes can easily and usefully be chosen in order to support the social and economic development of the regions that have been visited, and this in an interbranch sense. Let us mention for instance "Water", "Soil erosion" ..

The courses gather young people, mainly during the holidays, in order to work in the school, university or industrial laboratories (physics, chemistry, biology, astronautics..). Once more, themes can be usefully chosen among the important problems humanity has to face, principally the environment pollution, the green revolution (the hunger problem), the demographic explosion,...

Some ICC member associations, for instance, the *Mouvement Jeunes-Science de Tunisie*, have already organized such camps for some years In the reports we have received, we have found the following orientations:

The working programmes often cover various branches of sciences (e.g.: various branches of natural sciences and electronics); this method emphasizes the interrelations of the various scientific subjects;

The purpose is not to give a thorough education to the participants in the studied branches, but to familiarize them with terminology, scientific bases, technology and the short-term accessible experiments;

The use of audio-visual means is strongly advised as well as the use of previous information notes on handlings and important themes;

The participation is not systematically limited only to the national, on the contrary, places are often offered to young foreigners, preferably in the neighbour countries because of the difficulties of obtaining travel scholarships.

Numerous developing countries have mentioned their intention to create or develop a science camp programme in the next year, be it in Africa, Latin America or Asia.

On the occasion of our next ICC General Assembly, taking place in New Delhi from the 18 to the 21 December, 1970, our works will cover, principally, the study of a *project*: the purpose would be to find the means of *forming leaders* (adult educators and students) who could, afterwards, organize science camps in their own countries.

We are led to tackle numerous impor-

tant questions during these debates:

The role of camps in the training of organizers and cadres: should not use be made first and foremost of the methods of the science camp for training organizers and qualified personnel?

To what extent should the work of science camps be directed towards achievements of general interest (e.g. application of natural science to agriculture) or permanent activities (e.g. construction of rural museums)?

To what extent should science camps be used to foster contact between rural and urban youth?

On what scale should a programme of camps or courses be developed: local, regional, national or international?

For youth institutions that do not specialize in science activities, would it not be possible to apply science camp methods to increase the number of participants capable of strengthening their science activity?

The essential questions should not lead us to forget the *more technical problems*: the success (or not) of a camp or a course depends on this too.

Factors determining choice of camp sites;

Numbers and quality of staff,

Source and abundance of equipment material,

Origin of participants (students, young apprentices, rural youth, etc., requirements for selecting members;

Length of the activity;

Establishment of the work programme: harvesting, practical laboratory work, debates, social life, etc

POPULAR SCIENCE CENTRES—MUSEUMS

Scientific and technological museums should no longer be conceived as mere collections of objects. Where they exist they should become more and more closely integrated with the educational and or popular education systems.

Consequently, it is particularly important to seek out every means of transforming existing science museums into "Popular Science Centres", or to create such centres where activities such as science clubs, exhibitions of scientific projects, competitions, courses, public courses, public lectures, loans of material, etc. . may be deveploed in quality and quantity.

We wish to cooperate with other specialized organizations in order to precise the best way to study this development of the educative action of the Popular Science Centres (museums) and planetaria.

The too fragmentary information collected for this report leads to draw our attention on an interesting programme provided by India

In India, the two main science museums and the planetarium are situated in the big towns. So, in order to apply the advantages of the museums and the audio-visual methods for the rural populations, the Birla Industrial and Technological Museum of Calcutta, has developed the idea. of mobile museums These travel through the country, carrying science fairs Demonstrators are responsible of these "buses"; they explain the exhibited projects in simple words or in the language of the region. For an improvement of the quality and quantity of these demonstrations, those "musobuses" can be an important instrument for the propagation of science among young countrymen, and rural populations.

The Birla Industrial and Technological Museum (B.I.T M) has been set up, run and financed by the Council of Scientific and Industrial Research under the

Ministry of Education of the Government of India The museum is situated in Calcutta, the capital of the State of West Bengal (having a population of 35.5 million), and is operating its activities on the State of West Bengal and its adjoining areas.

The main *objectives* of this museum are to portray the history of science and technology with the help of permanent exhibitions, to create the scientific awareness among the common people, and to complete the science education in schools by means of audio-visual demonstrations.

To achieve the first objective, this museum has set up ten galleries devoted to various branches of science and technology; and they plan to establish a new one. The branches are· nuclear physics, motive power, mining, copper, iron and steel, petroleum, electricity, television and electronics, communications, and as project, transports

The second objective is also achieved to some extent by the permanent exhibitions of the museum. However, this museum is visited mainly by the urban population; to reach the rural populations, mobile exhibitions are organized.

The exhibits are mounted on a specially equipped "bus" and which serves as the exhibition hall. In 1968, there were 4 mobile units; devoted, among others, to the following subjects: "Our Familiar Electricity", "Transformation of Energy", "Light and Sight." The Birla Museum has also set up Regional Science Museums in the district towns of West Bengal (4 in 1969).

The third objective is achieved mainly by activities such as "Science Demonstration Lectures", "Creative Abilities Centres", "Teacher Training Programmes", "Film Shows". These programmes are organized at the headquarters at Calcutta and also in the regional science museums. The purpose of these Science Demonstration lectures is to show to the school that science can be taught with the help of demonstration kits, and such kits can be fabricated by the students in the school, guided by teachers (in the "creative abilities centres") To train the teachers for these activities, Teacher Training Programmes are organized at Calcutta and in the regional science museums. (In this field, we remind the report set up in 1969 by the "Unesco Regional office for Education in Asia" and entitled "Planning for science teaching improvement in Asian schools.").

A centre of promotion of the creative abilities has been set up at the B.I.T.M. to encourage students to develop their scientific capacities by fabricating scientific devices and equipment The museum also organizes yearly eloquence competitions and science fairs for the students.

A new action started for the rural regions is the establishment by the National Council of Educational Research and Training (NCERT) of science centres *Vijnan Mandirs* in various villages of India; the purpose is to popularise science by demonstrations and its applications in the daily life.

These centres are engaged mainly in the problem of hygiene and health in rural districts Generally, small museums having collections of local flora and fauna are kept by these centres. Unfortunately, the multiplication of the science centres is limited by the insufficiency of the financial means and the lack of qualified people to direct them

Popular science centres or science museums have already been founded in many other developing Countries.

Institutionalization of the Out-of-School Science Activities

Considering the diversity of the subjects

that are studied, the out-of-school education tends inevitably to be less structured than the traditional teaching

For the developing countries, it seems necessary to ensure a certain *centralization of the efforts* if the wish to accelerate the development of the out-of-school science activities and to facilitate the application of the help that could be given by the rich countries is felt This preoccupation of Unesco and ICC to have the out-of-school science education "institutionalized" is taken into account in many developing countries.

We may remember the inquiry undertaken in 1968 by the Division of the Science Teaching of Unesco on the theme· "Scientific popularization activities in the member countries".

This inquiry tends to know if there are, in the member States, "governmental departments or high civil servants to stimulate the interest for science, to popularize science and to diffuse the scientific knowledge". If such a department does not exist, a second question tries to know the intentions of creation of such an officially recognized structure. Finally, if there is no structure and if the Governments do not foresee their short-term creation, Unesco asks with which officially recognized non-governmental organization "it is recommended to set up a cooperation in order to start a permanent activity in the field of science popularization.

From the examination of the answers of 35 developing countries, it appears that 26 countries have a governmental department responsible of stimulating the diffusion of the scientific knowledge (generally the Department responsible of the Scientific Research or the National Education). Two countries think of the next creation of such a structure and 7 countries mention that cooperation must temporarily be maintained with recognized non-governmental organizations.

We remind you that in 1970, with the technical and financial help of Unesco, ICC has published a new version of a repertory of the specialized associations for out-of-school science activities, publication entitled "Youth out-of-school science activities. List of the representative organizations". Ninety-four countries are represented, 62 of which are developing countries

As examples of "institutionalized" organisms — Ministerial Department, or governmental institutions, officially recognized, and sponsored by the governmental authorities we shall mention:

The National Council of Educational Research and Training (NCERT) and the Indian Association for Extra-curricular Scientific Activities (I.A E.A.A) in India, the National Science Club of Thailand in Thailand, the *Mouvement Jeunes-Science* in Tunis, and *Jeunes-Science du Rwanda*.

We may say that the national Council of Educational Research and Training has been established by the Government of India to undertake the study and the improvement of the teaching of science in the secondary schools. The NCERT has launched a vast programme of reforms, and recognizing the important role of the out-of-school science activities in modern scientific teaching, it has encouraged the formation of science clubs in the secondary school giving them starting subsidies. (In 1968, this institution had helped to the establishment of 1,100 science clubs and had trained 200 leaders for science clubs). The NCERT has also encouraged and helped to the organization of science fairs.

As to the Indian Association for Extra-curricular Scientific Activities, it was created

to coordinate and promote on a national scale, the out-of-school science activities and the popularization of scientific culture Its activities include, among others, the organization and the development of science clubs, of *Vijnan Mandirs*, urban and rural science centres, science fairs and science camps, science museums, and the production of science films, reviews, and books, kits,... these activities are undertaken together with other national and governmental organizations, devoted to out-of-school science activities.

In Thailand, most of the school science clubs are affiliated to the "Science Club of Thailand", a non-governmental organization, included in the Science Society of Thailand, which has benefits of the Royal Patronage. The objectives of this institution are principally, to promote the establishment of science clubs in the school to help the existing clubs to achieve their activities, to be an information centre on the science activities and to organize yearly science fairs.

In this sense, it is interesting to mention the project of establishment of a National Science Centre at Kuala Lumpur (Malaysia), responsible of coordinating the different educative actions started in the country

This centre would include 4 units, and more particularly an *out-of-school special unit*. whose missions will be: to train teachers (in connection with the "Teacher Training Colleges") and laboratory technicians, encourage the out-of-school science activities and organize science fairs up to the national level, look for documentation and publish information reviews on the latest techniques, etc, and on science of education.

As to the *Mouvement Jeunes-Science* of Tunis, it has been created at the initiative of the association des Ingenieurset Techniciens Tunisiens (Association of Tunisian Engineers and Technicians), with the approval of the Delegation du Commissariat General a la Productivite en Tunisie (Delegation of the General Commissariat for Productivity in Tunis), with the *Mouvement Jeunes-Sciences* of France, with the help of the local representatives of the various tunisian economic and industrial branches, and the agreement and the support of the tunisian governmental authorities.

We may mention that the originality of the structures of this club lies in the fact that it is integrated in the "Association des Ingenieurs et Techniciens Tunisiens", Association who took the initiative of its creation and whose members are in this club's Council of Administration.

The ground for the construction of this club has been offered by the Tunis City Authorities, the building has been realized, thanks to the help of the Governmental Authorities and Tunisian and foreign private sectors, whereas the scientific equipment and the technical consultants have been, at the start, provided by the service of the French Technical and Scientific Assistance of the Ministry of Foreign Affairs.

This achievement constitutes a live and stimulating expression of the national and international cooperation and of its great possibilities for the developing countries in this vital field of youth and science.

Roles For Social Scientists In Environmental Education

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WHETHER a humanity or a social science, the discipline of history is related to environmental quality. Beacon Hill, Georgetown, Lookout Mountain, The Saarinen Gateway Arch in St Louis, Glacier National Park, Alcatraz, and countless historical sites and monuments are outward manifestations of that relationship. The work of the historian is inextricably linked with the development of our value systems By our sets of values we determine what we want to preserve of our environment and heritage. In the rebuilding of American cities, structures are often torn down because they are old In the process, we have sometimes exchanged a part of our character for a class facade, or for the blacktop of a parking lot. By communicating with architects and city planners. historians can assist in the decision-making process relative to the kinds of surroundings which will reflect the values of our society

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The historian also has a role as a chronicler of the environmental-quality movement. As such, he perceives that it did not spring full-blown onto the American scene, but had its antecedents in earlier conservation activities. John Muir, Gifford Pinchot, and Theodore Roosevelt are known as pioneers in this movement Fairfield Osborn (2) William Vogt (5), and Rachael Carson (1) are latter-day exponents whose contributions deserve a place in this chronicle

Because a concern with the dead past and primitive cultures is frequently attributed to archaeology and anthropology, these fields may not at first appear to relate to environmental quality Italian subway builders might take issue with this proposition. Repeated attemtps to build a new tunnel in downtown Rome have been thwarted when old ruins have been encountered Each time alternative routes had to be planned. Recently in Atlanta, Georgia, construction work on a new shopping center was delayed for weeks in order to give archaeologists time to complete a "dig" when Indian relics were uncovered by buldozers. Anthropological studies of present-day communities of people who live in harmony with their environment will be increasingly important as social and technological changes bring more manipulation of those environments, as on Nauru Island where phosphate mining is eating away the island itself (3). Anthropologists, as well as other social scientists, are especially concerned with how man perceives his environment, and with the customs, institutions, and mores he conceives in an effort to rationalize that environment.

Among the social scientists, the political scientist now has one of the more important roles in relation to environmental quality. Many of our laws are based on traditional freedoms, such as riparian rights, mineral rights, and sovereignty of the seas, which

come in conflict with emerging attitudes toward environmental quality Legislation which established soil conservancy districts can be referred to as a model of how an environmental problem can be approached by legal means. New federal and state laws are establishing standards of quality for our air and water, and providing the means for achieving and enforcing those standards. Beyond the letter of the law lies the power structure of our society. The political scientist is aware of the means by which pressure groups work to achieve their desired goals.

The sociologist is also concerned with the group structure of our society. Race, caste, and prejudice play a part in the quality of our environments During the same month as the President's State of the Union message on environmental quality, vandals roamed through the Prutt-Igoe housing project in St Louis. They smashed windows that ordinarily project water pipes from freezing. Burst pipes caused 10,000 residents to spend a weekend in freezing misery. Subsequent renovation will cost close to a million dollars. At the time of its opening in 1954, the Prutt-Igoe housing project was widely acclaimed for its design The public looks to the sociologist and psychologist for some explanations of the motivations, frustrations, and fears which have transformed so much of our public housing into monstrous high-rise slums.

The rural landscape is not without its sociological problems related to the quality of the environment. Mechanization and farm consolidation are the basis for migrations leading to ghettos. The underemployed and destitute who remain on the land may suffer malnutrition and hunger in substandard housing which gives credit to the world's most prosperous nation.

Sociologists and demographers study the age-sex composition of various populations. Data on birth rates are indicative of trends in population growth, a basic factor in environmental problems Warning signs have gone up, the outcomes of population control lies in unpredictable areas of human behaviour relative to contraception, abortion, hunger, disease, and nuclear warfare.

Economists point to the disparity between unlimited wants and limited resources as a factor in environmental quality. Plainly, many of our environmental problems are an outgrowth of the industrial and technological revolution They are complicated by the high rate of product consumption within our society The costs of alleviating industrial pollution of our air and water are ultimately borne by the consumer. Now, however, these costs are being taken into consideration more and more in determining the profit to a community and region in locating an industrial facility within the area. By the use of simulations and a systems approach, economists can contribute to intelligent planning and zoning.

Last but not least, the geographer has traditionally called for the conservation of our natural resources (4) In essence, the cultural geographer is a human ecologist. As such he is vitally concerned with myriads of interrelation ships within the ecosystem. His particular skill in analyzing site factors, routes, and land-uses especially equip him to deal with problems of environmental quality. Paradoxically, on the issues of environmental quality, geographers have not been in public eye to the extent that ecologists have.

Two branches of geography deserve particular mention in connection with environmental quality Historical geography, with its emphasis on sequent occupance, can demonstrate the changes which occur in the environmental quality of an area through

time. Settlement geography, in part, focusses on frontier areas of the world where man is beginning to impinge upon his environment in sufficient numbers to cause problems.

From the foregoing, an overriding idea becomes clear. Whereas each of the social science disciplines has its particular point of view regarding problems of environmental quality, the problems themselves are a common concern Thus, concerted action regarding these problems calls for interdisciplinary cooperation, not just among the social scientists, but also between social scientists and natural scientists.

In addition to a role within a discipline, social scientists also function as researchers, technicians, and teachers. Some of the areas for exploring human behaviour as related to environmental quality have been indicated In delving into these areas, researchers will test hypotheses and accumulate more data leading to new insights into environmental problems.

The social science technician actually works on day-to-day problems associated with environmental quality He maps the blighted areas of cities or seeks alternative expressway locations As a social workers, he or she may work directly with people, especially in trying to improve home environments. Not only in government, but also in business, can persons trained in the social sciences contribute to the better management of our surroundings.

Teachers have a special responsibility in the matter of environmental quality. The time lag between cause and effect in environmental matters can be compared to the gap that separates the high school student from the adult The battleship Arizona went to its grave almost 30 years ago Oil from its sunken bulk still seeps to the surface at Pearl Harbor If all use of DDT were stepped now, some would still reach Antarctic penguins 10-years hence Further effects of the population explosion lie ahead.

Under such circumstances, the civics that cannot confine his classes to the content of the constitution. History teachers cannot simply rehash former happenings. Geography teachers must do more than girdle the globe. Social science instruction will have to operate in the affective domain. Students "turn on" when it comes to problems of environmental quality, like the Ohio high schoolers who wound up a study of pollution in Lake Erie by appearing before a Senate committee Or they become involved like the students "in a school in Connecticut who gained national recognition for their PYE (Protect Your Environment) Club. Through study trips and first-hand contact with decision makers, classes can enter the affective domain

In the last analysis, all social scientists operate in the role of citizens Currently the wolf cry is being raised on environmental problems Is the danger real? As in a fable about the boy who cried wolf, will citizens disregard the warnings after a time? The social scientist as a citizen has an obligation to help bring about better human responses that will result in a higher quality of life for the people of this earth.

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Frontiers of Science and Higher States of Consciousness

Transcendental Meditation Under Scientific Investigation held at Cala Millor, Mallorca, Spain

AN international scientific conference was held at Cala Millor (February 26-March 1). Eminent scientists came at the invitation of the Maharishi Mahesh Yogi. The conference coincided with the teacher-training course in transcendental meditation which may be defined as a technique for turning the attention inwards towards the subtle levels of a thought until the mind transcends the experience of the subtlest state of the thought and arrives at the source of thought The main result is the removal or dissolving of deep-rooted stresses and strains in the nervous system, types which are not removable even during deep sleep. By removing such tension which otherwise hinders effective performance of activity, greater and more complete integrated use of all levels of the nervous system results and a refinement of all

Maharishi Mahesh Yogi, discussing recent scientific research on Transcendental Meditation with (From left to right) Dr. R.K Wallace, Harvard University, Boston, Massachusetts, Prof. M. Melvin, Temple University, Philadelphia, Pennsylvania and Dr. D. Kannellakos, Stanford Research Institute, Menlo Park, California.

senses of perception occurs. Improved perception means greater efficiency in all fields of life

Those attending the course consist of over 800 men and women from all over Europe, the United States and Canada. They are of all ages and professions, but predominantly university students and professional people

The following scientists participated in the conference:

Dr. Herbert Benson, M.D Thorndyke Memorial Laboratory, Harvard Medical school, United States.

Dr. Robert Keith Wallace, Ph.D. doing post-doctoral research at the Harvard Medical School, United States.

Dr. A. Campbell, M.D., Editor, *The Hospital Times*, England. Dr. Demetri Kanellakos, Ph.D., Senior Research Engineer in Radio Physics, Stanford Research Institute, United States.

Dr. Dean Brown, Senior Research Engineer, Stanford Research Institute, United States.

Dr. Kurt Vanselow, Professor of Physics, Kiel University, Germany.

Dr. Mael Melvin, Professor of Physics, Temple University, United States.

Garland Landreth, doing graduate study in psychology with Professor Maynard Shelly at Kansas University, U S.A.

The conference divided itself into two parts—reports of research work already done and in progress; and talks concerning future possibilities for scientific investigation into Transcendental Meditation and its application. Dr. Herbert Benson presented the work that he and Dr Keith Wallace have done on the *physiological and bio-chemical changes* which take place during Transcendental Meditation Tests had been made of Total oxygen consumption, signifying the metabolic rate of the body and decreases of up to 17 per cent were observed *Cardiac Output*, the work load of the heart, was seen to be reduced by about 25 per cent Skin resistance showed increases of several hundred per cent. The *skin resistance* figure is used as an indication of emotional tension, for example, in the lie-detector a low reading indicates high emotional tension. The high figures recorded with meditating subjects appear to indicate exceptional states of relaxation. The *Lactate Ion Concentration* in the blood, suspected to have effects upon muscle-tone and anxiety states, was found to decrease by 33 per cent. Arterial Blood Gases did not change appreciably, signifying the continuation of normal circulatory function during Transcendental Meditation. The Respiratory and Heart Rates decreased, indicating states of deep rest in the subject. *Electroencephalograph Recordings* indicated an unusual abundance of Alpha Waves (8-12-Hz) measurable in the frontal and top regions as well in the occipital areas of the brain. Certain subjects, showed Theta waves (5-8 Hz) These recordings indicated that the brain is in a state of restful alertness during meditation Applying this observation to that of the low metabolic rates, Dr Benson proposed that this showed evidence that Transcendental Meditation produces physiological changes different from those seen in normal waking, dreaming and deep states and from hypnotic states. He gave the name *Wakeful Hypometabolic State* to this newly observed phenomenon. He said he had noted that transcendental meditators appear to have rather low blood pressure which is a most desirable condition, he emphasised Dr. Benson, who is an

Paper contributed by the General Secretary, Spiritual Regeneration Movement Foundation of India, Rishikesh (U.P.).

eminent research cardiologist working in one of the oldest and most highly respected research laboratories in the U.S. went on to make some tentative evaluations of his and Dr. Wallace's findings. He pointed out that coronary heart disease, directly attributable to hypertension, is now-a-days the biggest killer disease of all in the western hemisphere. He propounded the theory that man's fight or flight mechanism, instinctively based and having played a significant part in the survival of the species in the past, could be becoming dangerously redundant. Modern living provides continual stimuli for the triggering of the fight or flight mechanism but few opportunities either to flight or to flee. This produces unresolved tensions in the organism which could possibly account for high blood pressure as well as other psychosomatic manifestations of an undesirable kind. He thinks that it is possible that the practice of Transcendental Meditation might have the effect of raising the threshold of fight or flight triggering or, at least, of minimizing the adverse effects.

The possible clinical applications of Transcendental Meditation in conditions such as high blood pressure, coronary heart disease, and various psychosomatic diseases were discussed. A study is now under way at Harvard to objectively assess reports by transcendental meditators of substantial improvement in cases of high blood pressure.

Dr Benson concluded his talk with a report on Transcendental Meditation and *Drug Abuse*. He described an exploratory survey carried out in the United States by him and Dr. Wallace in which 1,862 people who had been meditating for three months or longer completed a questionnaire dealing with the use of drugs, liquor and tobacco. Most participants had been to college and many held degrees. The survey indicated a sharp decrease in drug abuse including cigarettes and liquor within three months of starting the practice of Transcendental Meditation, and this decrease was progressively maintained until after 21 months, most of the subjects claimed to have stopped abusing drugs, cigarettes and liquor entirely. Most subjects were of the opinion that Transcendental Meditation had been largely responsible for their discontinuation of drug abuse.

As a result of the presentation of these findings at the Drug Abuse International Symposium for Physicians at the University of Michigan, Anne Arbour, November, 1970, much scientific interest has been aroused by this highly interesting side-effect of Transcendental Meditation and funds have become available for a larger controlled survey which is now being prepared.

Professor Kurt Vanselow took up Dr Benson's theme of the possible interconnection between Transcendental Meditation and the field of instinctual response. Recent work in Germany seems to indicate that the stresses of competitive education may produce hormonal changes in children, the effects of which could menace their adult life.

One of the participants of the teacher-training course, Garland Landryth who is presently working towards a Ph.D. in psychology, summarized the results of a recent study conducted with Professor M. Shelly of the University of Kansas. A group of meditators was compared with a control group of non-meditators and it was found that meditators are generally happier, more relaxed and develop richer and deeper personal relationships. They seem to be capable of adapting themselves more spontaneously to their environment and do not depend on their surroundings for their happiness. Transcendental Meditators exhi-

bit many of the characteristics of a 'self-actualized person', as defined by one of the greatest psychologists of our age, Abraham Meslow Transcendental Meditation, because it is the way to gain this fulfilment is the most important solution to today's problems, concluded the speaker.

Dr. Mael Melvin, drawing comparisons between the basis of thought in the human process of cerebration and the ground underlying the existence of matter at its finest level in the proton and in other sub-atomic particles, related the Quantum Field Theory to Transcendental Meditation.

For the remainder of the conference the speakers were concerned with future possibilities. Dr. Dean Brown, a physicist and computer specialist at Stanford Research Institute is now engaged in a project to remodel the educational system of Spain under the auspices of Unesco, the World Bank and the Spanish Government. He described his research into the description of the process of creation as contained in the Vedas.

Based on Dr. D. Kanellakos' recent research entitled 'The Physiology of the Evolving Man', the conclusion was reached at Stanford Research Institute that the practice of Transcendental Meditation, as taught by the Maharishi Mahesh Yogi has physiological concommitants that distinguish the state reached in Transcendental Meditation from the currently recognised states of human existence —namely, wakefulness, dreaming and deep sleep. The physiological and biochemical changes which occur during the time one is in the transcendental state seems to remove the stresses so deeply imbedded in the nervous system, that not even deep sleep or dreaming can remove or dissolve them Only the profoundly deep rest attained through Transcendental Meditation seems to reach these stresses and allow them to be dissolved naturally

Dr Kanellakos' project led to the acceptance of Transcendental Meditation as a proper subject for research at various scientific laboratories. He made a plea for an inter-disciplinary programme of research into the effects of Transcendental Meditation for which he has prepared a thesis mapping out the work to be done by the life, engineering, computer and behavioural science departments of his foundation.

Dr. A. Campbell announced the inauguration of a new journal to be called 'Creative Intelligence'. This journal will be publishing articles such as those presented by Drs. Melvin, Brown and Kanellakos.

It is interesting to note that the scientific application of Transcendental Meditation is being taught in the universities of the United States, England and Canada as a new subject, 'The Science of Creative Intelligence'

The conference closed with the feeling that some steps had been taken toward establishing a very important reconciliation between Philosophy as represented by Transcendental Meditation and the Sciences.

Maharishi Mahesh Yogi concluded saying that when these 800 course participants join those teachers already at work, plus those yet to be trained during the next two years, there will be enough teachers of Transcendental Meditation for all countries of the world. His plan is to establish centres universally making available to all the people this simple technique for integrated life so that all can enjoy 200 per cent of life, 100 per cent spiritual and 100 per cent material through Transcendental Meditation. 'When one per cent of the world's population meditates, Maharishi Mahesh Yogi pointed out, 'then the eradication of suffering and war from our society will be well on its way.'

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Produce, Yes— Pollute, No

WILLIAM H. STRINGER

ON every hand the warning is sounded that mankind is so dangerously polluting the earth that, before long, it will become unfit for human habitation. But there is a remedy—wiser and better technology.

In the United States many ecologists, industrial experts and government officials have realised that industrial processes and the general activity of civilised mankind can be so handled that pollution is vastly reduced or never happens at all. American companies are devoting millions of dollars and long hours of research to this new technology.

For example, to eliminate pollution from automobile exhausts, electric engines which produce virtually no pollution are being developed. To perfect these new engines, instead of tinkering with the old, is what is meant by the 'new' environmental technology.

Now in the United States the antipollution drive is spurring the development of new devices and processes in an industry expending $ 5,000 million a year. Among the new devices are plastic containers, that disintegrate in a few months; and a solid-waste disposal plant that pulverises all kinds of refuse, creating no odours and producing fertilisers and soil conditioners as the end result

Murray Weidenbaum, Assistant Secretary of the Treasury, states the essential aim in this comment made to a New York environmental conference: 'I am offended by the prospect of our having to devote an ever larger share of our national resources to cleaning up an ever faster growing mountain of pollution. Rather, the desirability of adopting methods of producing and consuming which are less polluting than our present practices seems to be required.'

Given the correct technology, protection of the environment may, in the end, actually cost a country less than would unrestrained pollution.

A recent study by the *U.S. News and World Report* concludes that the pollution clean-up job in the United States will cost $ 71,000 million over the next five years This includes $ 13,000 million to combat dirty air and $ 4,000 million for better disposal of solid wastes

If the expense of freshening the air comes to $ 2,600 million annually, and damage to the economy from polluted air is about $ 13,500 million, as recent estimates have it, then cleaner air can save the economy some $ 11,000 million a year.

One of the great challenges is how to handle solid wastes—the refuse which consumers, homes, factories, cities throw away. It is estimated that some individuals

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Reprinted from *The American Reporter*.

in rich countries account for six pounds (2.7 Kilograms) of waste per day.

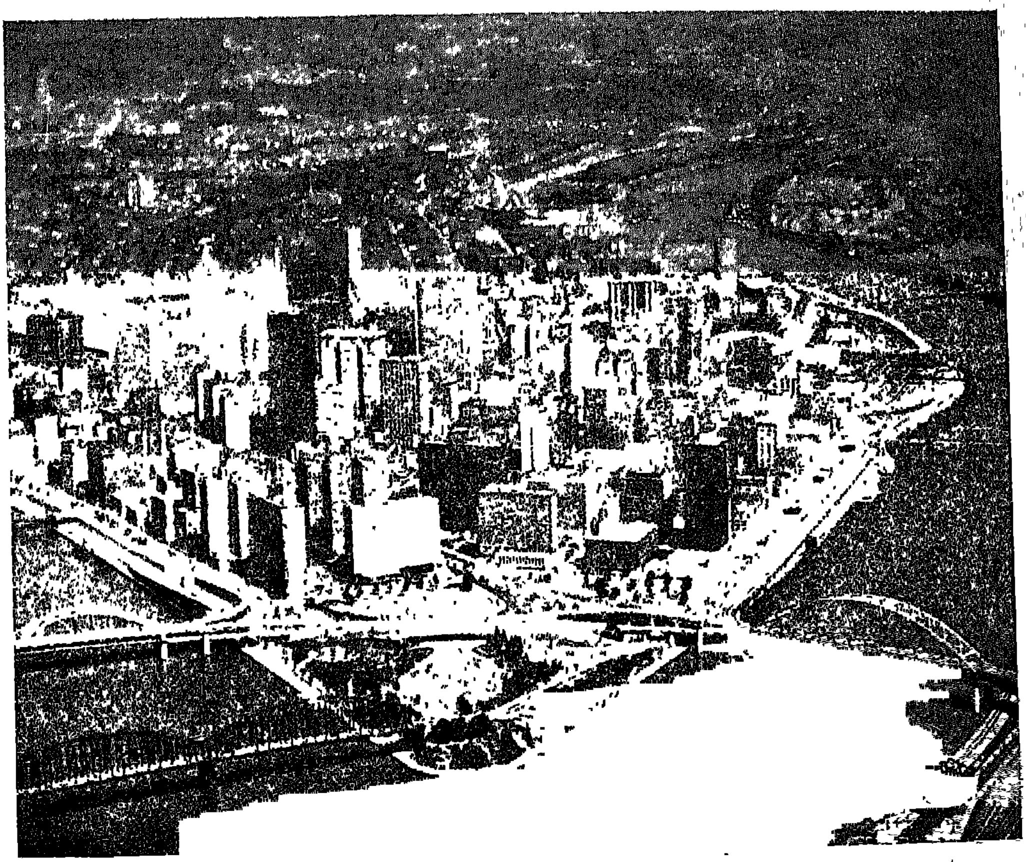
One recent solution has been to step up the public investment in more efficient incinerators for burning up the waste. But beyond improved incineration, the real long-term answer, it is being realised, is to re-use, recycle, the solid wastes.

Recycling, of course, has been a familiar process for some time. Over half the American output of steel is reclaimed scrap. The same is true of copper. Twice as much lead is recovered as is currently being mined.

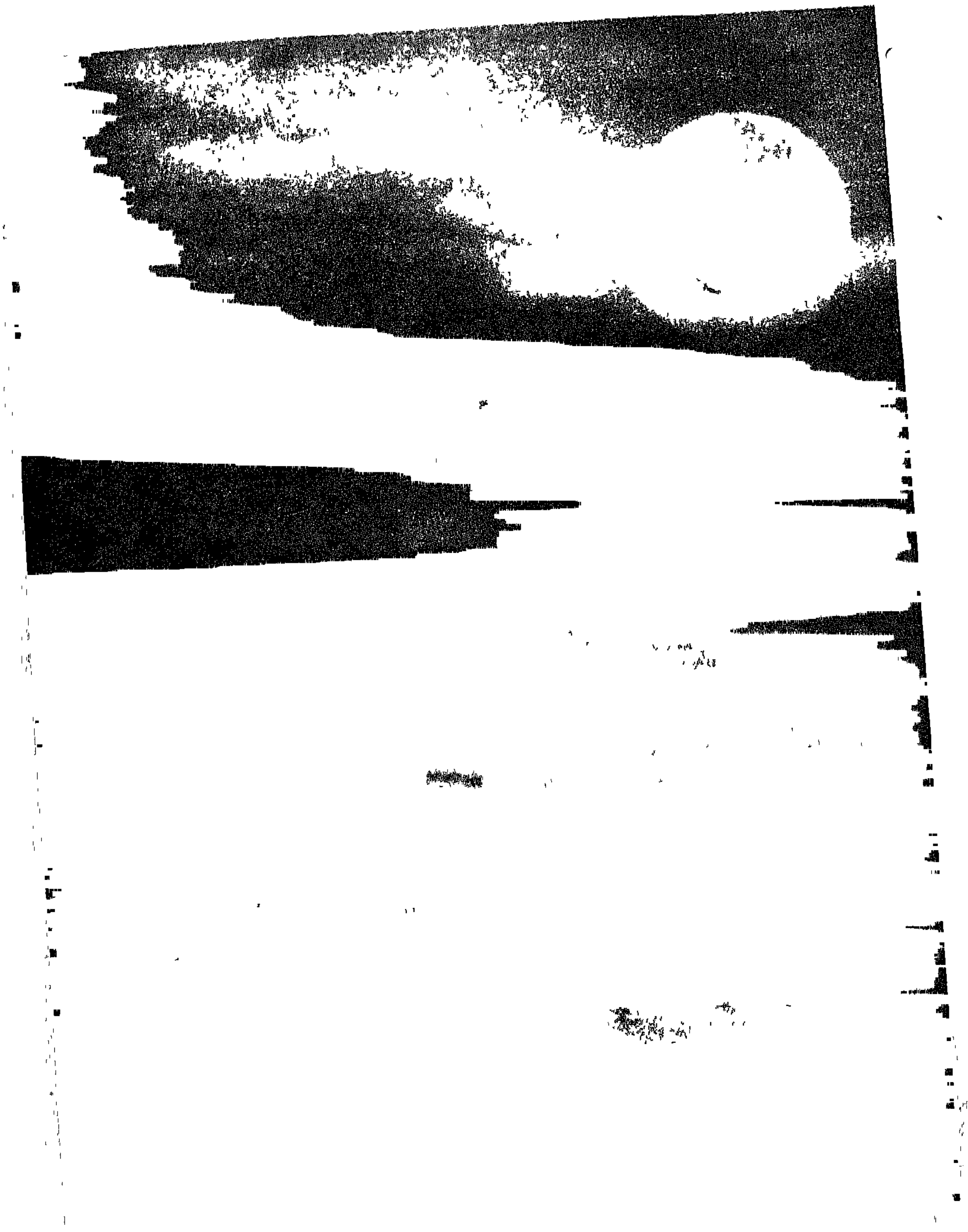
As for water purification, a great deal of American municipal and industrial waste water now undergoes some form of treatment for removal of filth and organic waste matter.

What is now advocated is an additional treatment which would definitely remove the salts, dyes, acids, persistent insecticides and herbicides also

It is also possible to treat sewage with a view to recycling it immediately. And of course, some processes treat the sewage sludge as fertiliser, which can be sold to



Pittsburgh, Pennsylvania, is known for its steel production. Once it was also known for its air pollution. This is how its downtown area is today.



Pennsylvama on 22 January 1937

farmers or used to cover the raw earth produced by strip mining

Anti-pollution is becoming a big source of jobs in the United States. An estimated 250,000 jobs were developed in fields related to pollution control in the years 1957-69. Now the figure is 655,900. According to Herbert Bienstock, a Department of Labour official, the job figure could go to 1,200,000 by 1980

Pollution control thus is becoming one of the 'growth industries' in the United States, and so it will be in other concerned countries as the vast possibilities of wise environment-protecting technology become evident.

Teaching Science Through Discovery

J.K. Sood

Regional College of Education, Ajmer

IN most of the classrooms science is being taught and learned as a body of fact, which are infallible, unalterable and once studied shall serve life-long to the individual. If we continue with these cliches, we are sure to continue with rote memorization of mere facts and minutiae of science on the part of the learner and the science teacher shall continue to function as a disseminator of information. This is evident even in those classrooms where teachers are graduates and post-graduates in science. The situation is worse at the primary stage where even teachers are not qualified in science subjects what to say of equipment and other facilities in science teaching. But the brute fact of the matter is different. Science teacher is neither a purveyor of scientific information nor an initiator of learning for learning's sake but he is a stage setter and children are initiated from "learning to thinking" This will help in preparing critical thinkers, ready to meet the challenges of unknown, unpredictable future. This is the purpose of science teaching where we relate present with future in classrooms and children learn many abilities to function as a problem solver "par excellence"; a rare quality of a working scientist.

The Changing Concept of Science

A valid and functional concept of science and the use of the proper methods of teaching science will make science teaching and learning effective and useful. When we talk of science merely as a body of hard facts, we miss a significant part of it We call it *processes of science* or the modes and methods of discovering the knowledge or facts of science. Joseph J Schwab thinks that science should not be taken only as a "rhetoric of conclusions" but it should also include the "exhibition of the course of inquiry" Study of science should help in uncovering the laws of nature. After all "science is the interpretation of nature and man is its interpretor". Science has assumed a dynamic outlook. The findings of science are tentative and stand for correction in the light of new evidences Scientific knowledge is revisionary in character with a "temporary codex". Even doctrines of long standing were altered by new findings by new evidences The history of science is studded with many glaring examples to substantiate it Hurd has very aptly presented an emerging concept of science. "Facts in and themselves simply do not make a science. A science is not simply an abstraction from empirical data, but an intellectual creation often suggested by the data. It is the discovery of order among the data that makes the science..... Science is an intellectual activity which arises from personal experience and takes place in the minds of men. It is simply a way of using human intelligence to achieve a better under-

standing of nature and nature's laws" (Hurd, 1969)

To initiate intellectual activity in classrooms, we need emphasis on the *processes of science* or modes of discovering scientific knowledge. This changing concept of science demands a change in our teaching, in our institutions, and in ourselves who are working as science teachers. While a child is passing through the process, he acquires the concepts of science, gathers information of conceptual schemes and ultimately gets an idea of the structure of science. Therefore, it is essential that we understand the proper and deeper meaning of science, inherited in its nature and practice discovery learning to find the structure of science.

What is Discovery ?

The prominent workers in the field of science education advocate the use of discovery method/inquiry approach in science teaching. Many strongly favour the use of problem-solving method Webster's American Dictionary interprets discovery as. to discover means to know; to find out, to uncover it, etc., and discovery means anything discovered. Similarly, to inquire means to seek information and inquiry means an investigation or examination, etc. Other workers describe discovery/inquiry as an attitude, a state of mind; a way of learning; a process of investigation, an uncovering, and a search for truth. There seems to be subtle difference between discovery approach and inquiry method. On problem solving, of course, David P Ausubel contends that it involves discovery learning, if problem solving is meaningful and worthwhile

The aforesaid meanings of discovery/inquiry appear to be skin deep and peripherial A critical analysis of few definitions along with some examples will clarify it further

On enquiry Schwab states, "To teach science as enquiry means, first, to show students how knowledge arises from the interpretation of data. It means, second, to show students that the interpretation of data—indeed, even the search for data—proceeds on the basis of concepts and assumptions that change as our knowledge grows. It means, third, to show students that because these principles and concepts change, knowledge changes too . " (Schwab, 1963)

Gagne states that enquiry is apparently a set of activities characterized by a problem-solving approach in which each newly encountered phenomenon becomes a challenge for thinking (Gagne, 1963)

Bruner says " . I do not restrict discovery to the act of finding something that before was unknown to mankind, but rather include all forms of obtaining knowledge for oneself by the use of one's mind . permitting the student to put things together for himself, to be his own discoverer" (Bruner, 1961).

Now, let us examine two discovery-oriented activities.

Classification of objects. Students of primary classes were given a few seeds of different colour, shape, and size. The students were asked to classify them into different groups. Children observed things critically and tried to find out differences in physical properties. Many times, children changed an object in order to observe further minutely, some times used instruments or aids to find out details They repeated observations to improve reliability. Thus, on the basis of observation they perceived similarities and differences in these objects, separating them in different groups, develop arbitrary classi-

fication scheme, etc. While trying to recognize them, children were using the processes of science and simultaneously gaining scientific knowledge or concepts of science. At higher grade level students may classify animals and plants and may use their own criteria of classifying things.

Interdependence of plants and animals. A study of an aquarium will help in understanding the relationship of aquatic plants with fishes. Children learn about the living conditions of plants and animals They try to find out the significance of water temperature, acidity and alkalinity for living. Here, students use observational skills, classificational abilities, abilities of conducting experimentation and drawing inferences from recorded data To acquire the concept of 'habitat' students use different modes of inquiry

A few characteristics of discovery learning are discernible from the above mentioned definitions and examples.

1. Children participate actively in the process of learning.
2. Children try to learn themselves and in due course of time they become self learners
3. Children try to organize and systematize their findings which provide an opportunity for analytical thinking.
4. The role of the teacher is minimized. But he is not out from the teaching learning process He functions more as a 'manager' or 'organizer' of learning activities rather than a disseminator of information.

Is Discovery Approach New?

The recent resurgence of interest in the laboratory work, experimentation, show that discovery approach is recent in origin. But it is not so. The above mentioned characteristics of discovery approach show that many of these were in use since long. Today, it has gained currency because it has been included in all curricular programmes of science. A brief historical perspective is given here to peep into the various processes involved therein.

Socrates claimed that he never taught his students He raised questions and tried to present situations where students can find answers to their questions. Of course, it needs thinking on the part of the learner Socratic method is one of the glaring examples which present a few elements of discovery approach.

The Progressive Education Movement gives many significant strands of discovery approach. *Project method, activity method, problem solving*, and *child centered learning* emphasize on the active involvement of the child in the process of learning. Discovery is also associated with the *inductive method, scientific method* and Armstrong's *heuristic method* John Dewey's *How we Think*; *Education and Experience* highlighted many aspects of discovery approach in general and creative and critical thinking in particular. In the Post-Sputnic era Schwab, Bruner, Gagne', Suchman and Ausubel are the proponents of discovery approach. They are instrumental in popularising the use of discovery approach in science teaching.

Why Discovery Approach in Science Teaching?

There are many advantages to the learner when he applies discovery approach in learning science. Bruner contends (in general) that discovery helps in (1) the increase in intellectual potency, (2) shift from extrinsic to intrinsic rewards, (3) learning the heuristics of discovery, (4) the aid of memory process (Bruner, 1961)

Teaching science through discovery shows 'science in operation' Here, we can emphasize processes of science, a significant aspect of science

Children try to find out concepts of science when they learn science through discovery They also learn that science is more than mere facts given in books or mentioned by the authorities because it was known to them Learning concepts of science, conceptual schemes in science give an idea of the structure of science Novak contends that 'the structure of science may be viewed as the system of major generalizations or concepts together with the *process* by which these concepts are obtained and enlarged'. Children will understand concepts as they see them in the context in which they emerge and grow

Discovery-based science programme take into consideration the natural characteristics (willingness to investigate, the ability to imagine procedures of doing work, etc) of children

Role of the Science Teacher in Discovery Learning

The science teacher has to play a key role in discovery learning. He has to create an intellectual climate in the classroom He carefully plans a sequence of learning activities covering a period of time. Planning involves preparation of instructional material suited to the particular age group The teacher is not only an 'initiator' of discovery teaching but he has to sustain the intellectual climate in the classroom till learners realize the significance of self learning. The science teacher also helps students in selecting proper activities, in identifiying proper topics and providing guidance.

Conclusion

There is enough scope for teaching science through discovery if we understand it properly and put sincere efforts It has its own values in learning. But discovery approach is not a panacea of all ills in science teaching It can be used through laboratory work, by experimentation, demonstration or by discussion It does not demand sophisticated instruments. There are a few observations which we should keep in view

1. Discovery approach is not applicable in all situations
2. A thorough study of different schools of thought in discovery learning is needed on the part of the teacher It includes ideas of John Dewey, Joseph J Schwab, Jerome S Bruner and Robert M Gagne'.
3. Psychological and sociological aspects of discovery learning should be studied thoroughly by the science teachers
4. Activities organized for learning through discovery should be consistent to the age level of children. A study of Jean Piaget's work on the development of intellectual abilities of children is needed and his views should be incorporated in the development of learning activities
5. Discovery approach may be practised from K through 11th grade.

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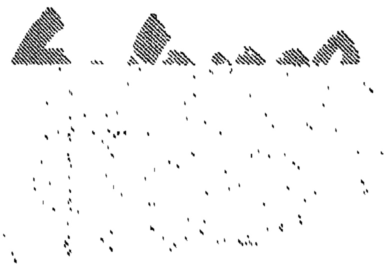

50 parts per million for oxides of nitrogen and of better than four parts per million for all other gases.

A 1969 Holden vehicle was used for the tests. The six cylinder 186 hp. motor was driven on an Anderson Chassis dynometer while the car was operating under a range of driving conditions

Although both these recently invented Australian anti-pollution devices are based upon well established principles, they embody some novel practical features.

Australian Devices Reduce Exhaust Pollution

A MOTOR car engine preheater invented by Mr. D. Wade of Sydney, Australia, reduced carbon monoxide in exhaust gases by about one-third, and hydrocarbons and oxides of nitrogen by about one-tenth.

Another anti-pollution device, developed by Mr L. Podhaizky of Melbourne, which supplies an air-water mixture to the engine manifold reduced carbon monoxide emission by about 90 per cent and hydrocarbons by 32 per cent. However, it increased the level of nitrogen oxides by some 90 per cent.

The figures were obtained during independent tests by Dr. H.C. Watson at the Department of Mechanical Engineering in the University of Melbourne. The equipment used gave a resolution accurate to

By Courtesy: Australian Information Service.

Could Fish Clear Canals ?

JOHN NEWELL

THE growing shortage of cheap labour in many agricultural nations has led to number of problems, including difficulty for the farmer in getting jobs like hedge-cutting or grass-clipping done properly, or at all. Another task for which labour is often not now available is the cutting of weed in drainage canals, ditches and streams.

Chemical herbicides can be unsuitable as they leave the weed to moulder and can cause pollution. Weed cutting machines are expensive to use and only suitable for the larger water-courses. An alternative now being intensively studied by scientists at the Government's Fresh Water Fisheries Laboratory and the Agricultural Research Council's Weed Research Organisation is to import freshwater fish to control the weeds by feeding on them.

The idea has much to recommend it. It involves no labour, no pollution, can be

self-perpetuating if the fish breed and even provides an edible end-product, the body of the fish. For one of another of these reasons, the idea of breeding such fish has been and is being studied in several parts of the world The most popular fish is the so called Asiatic grass carp, a different species from the indigenous European carp The Asiatic grass carp is now being experimented with as a source of food in eastern Europe, in Poland and Hungary The breeding programmes there are not concerned with weed control, only with carp for food. In Britain, the opposite is true Freshwater fish are unpopular as foodstuffs here But the fast-changing feeding habits of the British people lead some experts to feel that there's a good chance that carp may catch on here for food as well as weed control

The British team concerned carried out their experiments using nine indentical fish ponds, three emptied of all fish, six stocked only with carp. The ponds were used to check on how fast a given number or rather weight of carp could dispose of weed. The first series of experiments, recently completed, gave very encouraging results. The fish ate so much weed that the scientists believe that the main problem in using them for control is likely to be that they will eat too much rather than too little. Ecologists are anxious to ensure that not all the weed is cleared out of any ditch or canal, because it provides vital cover for other useful or harmless creatures to breed in. They are also concerned lest a population explosion of grass carp should take place throughout Britain's water systems Past experience has shown that this kind of thing is liable to happen when new methods of biological control are tried for the first time, unless very careful precautions have been taken beforehand.

However, the scientists are also hopeful that it will be possible to control the numbers of the carp and their effect on the weed quite easily. The carp are basically a semi-tropical species and their delicate young do not survive easily in colder climates. In fact breeding would be slow and sporadic do there is no danger of a population explosion. The carp would probably be bred in the warm water outlets from power stations, and then released where required and replenished at intervals from the breeding stations Polish research has shown that fertilizers added to fish ponds speed up the rate of plant growth making the fish reproduce four times faster than normal If the fish in the canals and ditches did become too numerous, then they could always have their numbers reduced by netting once or twice a year. But, although the idea is certainly looking attractive and encouraging now, the scientists concerned stress that grass carp are not the answer to every weed-choked river. Like machines or herbicides, or perhaps other weed-eating creatures, they are another tool which will find a useful niche as the relatively new science of ecology becomes more and more exact, enabling biologists to predict with greater and greater certainty the effects of introducing new factors into the balance of nature.

Reprinted from *Spectrum*, 82/1971.

New Directions in Teaching Secondary School Science

PAUL DEHART HURD, Rand McNally & Co., Chicago, 1969, pp. 239, $ 3.95.

TODAY, improvement of science teaching is a global phenomena In all countries efforts are being made to upgrade science curriculum as well as to improve the techniques of teaching. In the United States curriculum reformation is a story of last decade where unprecedented changes were initiated to improve school science. The launching of Sputnik I accelerated the pace of change. Sweeping changes took place primarily in secondary school science curriculum, followed by elementary school science reformation. The development of "alphabet" courses helped in projecting new dimensions which were tested on vigorus philosophical, educational parameters by top notch workers in these fields. In this continuing process of curriculum improvement many trends become a part of educational diet of school going children. *New Directions in Teaching Secondary School Science* presents such a rationale which reflects the spirit of "New Science" practised in American schools. It also presents impartial critical analysis of "alphabet" courses

In this book of Paul DeHart Hurd, a comprehensive, critical analysis of secondary school science teaching, which has been taking place since 1957, has been presented In the words of the author, "it is these trends in curriculum development, instruction, and learning, along with their underlying philosophical and psychological assumptions, that are critically examined in this book." *New Directions in Teaching Secondary School Science* is divided into seven chapters, dealing with. The Demand for Curriculum Reform; The Nature of Science and Science Curriculum; The Character of the Science Curriculum Reform; Concept Learning and the Structure of Science; Problems, Prospectives, and Prospects in Teaching High School Science, Trends in Evaluation of New Science Curricula; and Curriculum Models for Teaching Secondary School Science.

In the first six chapters, the author discusses philosophical and psychological aspects of secondary school science which gained currency during the Post-Sputnik era. It is also includes the contributions of Bruner and Piaget Chapter seven discusses different secondary school science curricular projects which are in vogue in different schools of the U.S.A. It covers approximately 80 pages of this book out of total 239.

The first chapter highlights the influences of the forces which are acting upon the contemporary society and demand an educa-

tional change. Oft-stated forces which geared the curriculum reformation in new direction are: an ever-increasing development of scientific knowledge; the enrolment explosion in schools; screening and up-dating of science content; impact of instructional technology; and influences of research in the field of teaching and learning. Science is taken as a future oriented discipline. Hence students of today should be oriented as well as prepared for the challenges of tomorrow. In other words students of today should be able to cope with the unpredictable future. This responsibility is to be shared by the education of today.

Second chapter presents a basic structure needed for the development of science curriculum. 'Science courses should be representative of science specially as science is known to scientists'. Science content is to be structured on concepts and conceptual schemes and should reflect the spirit of inquiry. These are the basic premises on which science curriculum shall be developed.

Chapters I and II identifies two significant aspects of science curriculum. First, in this complex scientifically oriented society rapid changes are inevitable Therefore, science curriculum needs not only revision but continuous reformation Secondly, science curriculum should include more of basic science than technology. This knowledge should have survival value and its teaching should be consistent with the nature of science.

In Chapters I and II arguments given by the author, have been necessarily condensed which makes some of it less accessible to the less widely read reader. But an exhaustive and relevant bibliography, given at the end of chapter two is a very welcome gesture to serve such category of people. In developing countries this topic needs an immediate and thorough discussion so that it becomes a part of science teacher's philosophy of teaching. Without clear understanding of the nature of science, the very style of teaching of the science teacher takes a different and sometimes disastrous course.

Chapters III and IV are the nucleus of this book. Different aspects of science teaching related to conventional courses and the shifting emphasis, as reflected in the new curricula, have been highlighted in Chapter III. Education for change, discipline centered curriculum; defining goals in terms of intellectual competencies, modes of inquiry suitable to exploring a discipline; concept formation; conceptual structure of a discipline in a coherence sequence, etc., are a few aspects which arrest attention of a worker in the field of curriculum

In Chapter IV, the author gives in detail ideas about concepts in science, concept learning, and the structure of science. It is very well illustrated with suitable examples taken from different curricular projects This chapter presents a line of action on concept learning rather than learning. The author has mentioned three references as background reading on this theme These are: AuSubel, *The Psychology of Learning*; Bruner, *Process of Education*; Gagne, *The Conditions of Learning* In the opinion of this reviewer two additional references shall prove useful for the workers in this field These are: Klausmeier and Harris (Eds.) *Analysis of Concept Learning*, and the work of Milton O. Pella and his associates conducted at the Centre for Cognitive Learning, University of Wisconsin, Madison, Wisconsin.

Dr. Hurd acquaints the reader with an adequate though brief analysis on concept learning, including a review of the variables affecting concept learning. Conceptual structure of the discipline woven with dis-

covery approach of teaching, is a central strategy in the development of science curriculum. This is a point of view of Dr Hurd which is palatable to most of the workers in science education.

In Chapter V problems and shortcomings of the new curricula have been discussed. New curricula is much sophisticated and is not related to societal needs. A few inadequacies in teacher education programme are also discussed. The author contends that in due course of time these shortcomings shall be removed from these materials.

The author has very correctly pointed out the shortcomings. It is self-evident from the recent developments in the schools of the U.S.A. Harvard Project Physics was initiated to check the fall in physics enrolment at the high school level. Biological Sciences Curriculum Study developed four different versions to meet the demands of different groups of students. Many curricular projects are trying to relate their courses with the needs of the society.

Chapter VI discusses relevancy and utility of the courses for children and society. Evaluation is taken as a very comprehensive term and expects rigorous continuous examination of content. It demands content, pedagogical, social and philosophical validities to see the utilmate effect of these courses on students and community.

The last chapter gives analytical analysis of curricular projects, namely, B.S.C.S., P.S.S.C., CHEM Study, H.P.P., E.S.C.P. and Time, Space, and Matter. An impartial assessment presents the worthiness of these materials. It is an excellent factual and analytical account of these projects.

Excellent bibliography and an index is an asset to all who are interested in the improvement of science teaching.

Since the beginning of curriculum reformation in the United States, Dr. Hurd is actively and passionately engaged in this venture. He has written tremendously for B S C.S., National Science Teacher's Association, lectured and provided consultant services on new approaches in science teaching. A book from the pen of such a dynamic personality is most welcome.

Perhaps the most interesting and certainly most challenging aspect of Dr. Hurd's efforts is to project future from the present. Very ably he has tried successfully to relate past, present and future. Most expected trends of future science education are given.

The book is very well organized, lucidly written with a wider coverage of all areas of science education The author is frank enough about his standpoint and attitude to the education of children in science.

This book is an essential reading for all science educators and science teachers. We have just initiated in science curricular reformation at the secondary stage. A thorough study of this text will save us from committing many mistakes. This is the contention of the present reviewer. To improve the worthiness of *learnability* and *teachability* in science, this book should be available in cheap edition and should be immediately translated in Hindi.

J.K. SOOD

Some Practical Applications of Binary Arithmetic

G.N SKOBELEV

AND

G S. BADERIA

ALTHOUGH mathematics is getting more and more abstract day by day, its applications are multiplying. In order that the students can see the powerful tool that mathematics provides, it is very important to give the pupils 'some' practical applications of modern mathematics.

In this article we shall show how it is possible to explain to the pupils first principles of the work of a summator in a computer.

To understand how the computer performs addition with speed and accuracy, the pupil has to know addition in the binary system. So after explaining the operations in binary arithmetic, we can explain to the pupil its practical applications.

The fact that in the binary system only two digits are needed to represent any number, makes this system convenient for many practical applications and, above all, for use in computers. One of the most important parts of a computer is the so-called summator which is used for adding two binary numbers.

In what follows, we shall be expressing numbers in 'base two' without mentioning the base each time. Observe the following additions in this base numbers for

10,	1010
101	1101
111	10111

In the first example, there is no carrying over at any stage. In the second example, starting from the extreme right, we have $0+1=1$, $1+0=1$, $0+1=1$, $1+1=10$. In the extreme left we have carrying over to the next 31 column.

Let us assume that we add two binary numbers and consider a certain column.

Addition in this column may or may not be with a carried over digit from the previous digit. Therefore, if we consider the addition of any two binary digits we shall have to investigate eight variants given in the table on the next page.

If we construct a summator to add any two digits we should foresee obtaining the necessary digit in the given column (the obtained digit) and when necessary foresee carrying over at the given stage (fourth, sixth, seventh and eighth lines of the table on the next page).

Representing a binary number in the summator may be roughly explained as below:

The summator is a combination of a large number of electrical circuits. In any electrical circuit the switch can be in two and in only two positions, viz. the "off" position and the "on" position. We may consider a summator to be designed in such a way that when the switch is "off" it represents "o" and when the switch is at the "on" position it represents "1". Let us consider one example. To represent the binary number 110101 in the summator it is necessary to set the first, third, fifth and sixth switches at the "on" position starting from the extreme right while the rest of the switches should be at the "off" position. Similarly, to represent the binary number 1000011 in the summator it is necessary to set the first, second and seventh switches from the extreme right at the "on" position and the rest of the switches at the "off" position.

Since in a binary system we use only two symbols namely "0" and "1" and since a switch in an electric circuit can be manipulated only

in two positions, it is obvious that the binary system is the most suitable system for computers.

The first binary digit	The second binary digit	Digit carried over to the given column from preceding column	The obtained digit in the given column	Digit carried over to the next column from the given one
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

We shall now consider the summator used in two binary digits for adding (Fig. 1). This summator has three inputs (A, B, K_1) and two outputs (C and K_2). The inputs A and B are necessary for putting two digits. If the digit A is "one", the corresponding switch automatically sets itself on the "on" position and thereby an electrical impulse is sent. If the digit A is "zero" the corresponding switch automatically sets itself on the "off" position and there is no impulse coming through A. We use the input B in a similar way.

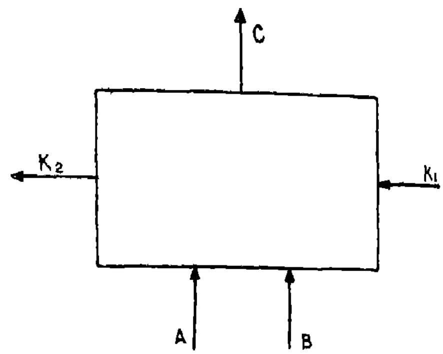

Fig. 1

The input K_1 gives us the possibility for carrying over "one" from the preceding summator. The output C shows the obtained result. If we obtain "one" the corresponding switch will be in "on" position, and there will be an impulse coming through C. If we obtain "zero" the corresponding switch will be in the "off" position, and there will be no impulse coming through C.

If, by adding three digits sent through inputs A, B, and K_1 we obtain in our summator 10 or 11, "one" will be carried over at this stage, which will be directed as an electrical impulse, into the next summator through the output k_2 In this case the corresponding switch will be in the "on" position, and an impulse will be sent through K_2.

If we obtain in our summator 1 or 0, there will be no carrying over, and no impulse will be sent through K_2.

Using the table above we can say quite definitely that there will be an impulse coming

through the output C in four cases :

1. If A=0, B=0, and $k_1=1$
2. If A=0, B=1, and $k_1=0$.
3. If A=1, B=0, and $k_1=0$.
4. If A=1, B=1, and $k_1=1$.

In other words the output C gives us an impulse either when there is one and only one impulse through one of the inputs, or when there are impulses through all the inputs. Similarly, through the output k_2, there is an impulse in the following four cases :

1. If A=0, B=1, and $k_1=1$.
2. If A=1, B=0, and $k_1=1$
3. If A=1, B=1, and $k_1=0$.
4. If A=1, B=1, and $k_1=1$.

In other words, we have an impulse through the output k_2 either when there are impulses through any two inputs, or when there are impulses through all the inputs.

The above summator enables us to add any two binary digits taking into consideration the carrying over from the preceding summator. To explain the addition of any two binary numbers, we consider the summator for numbers of six digits. Such a summator is a combination of the seven summator considered above (Fig. 2).

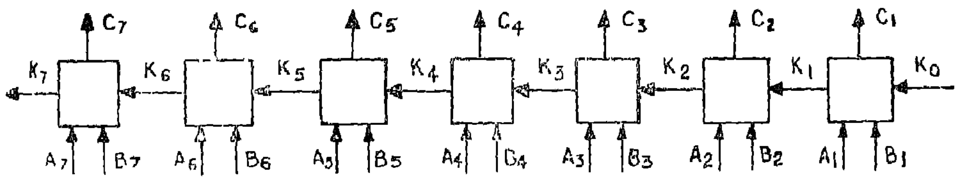

Fig. 2

Example . Add two binary numbers 101011 and 110001.

Solution:

To decide what to send through each input, we represent the numbers in a table below:

Inputs	A_7	A_6	A_5	A_4	A_3	A	A_1
First number	0	1	0	1	0	1	1
Inputs	B_7	B_6	B_5	B_4	B_3	B_2	B_1
Second number	0	1	1	0	0	0	1

So we set to the "on" position the switches A_1, A_2, A_4, A_6, B_1, B_5, B_6 (Fig. 3).

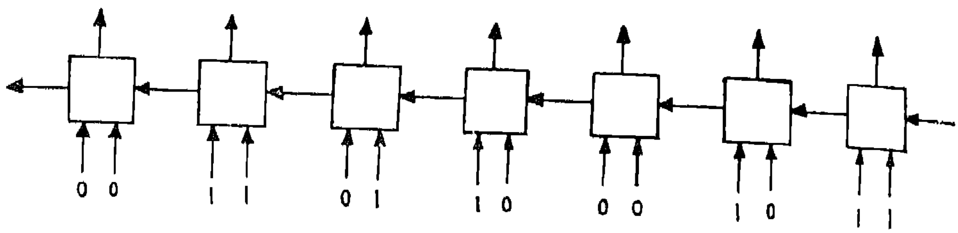

Fig. 3

Now the compound summator begins to work The summator at the extreme right is the first to start and works in the following way. As there are two impulses (through A_1 and B_1) we obtain no impulse through C_1 (the digit from the extreme right is 0), and there is impulse through k_1 (Fig. 4).

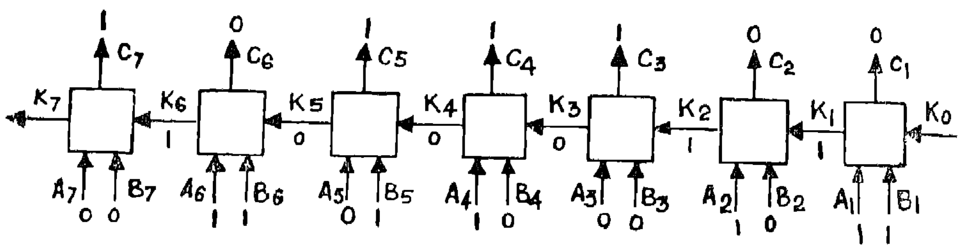

Fig. 4

In the second summator form the extreme right we have two impulses (through k_1 and A_2). Thus, there will be no impulse through C_2 but one impulse through k_2 (Fig. 5).

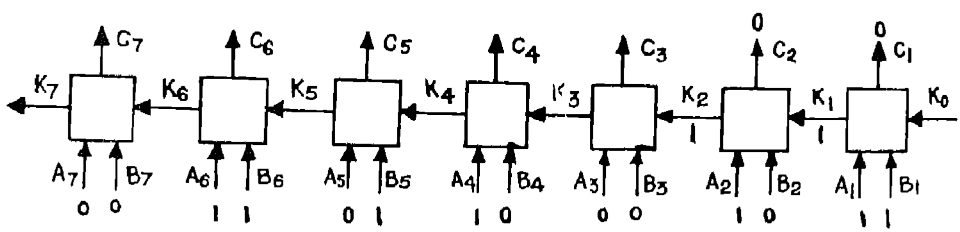

Fig. 5

This will go on, till addition is performed in each successive summator, Finally we get the result as shown in the diagram given on the next page (Fig. 6).

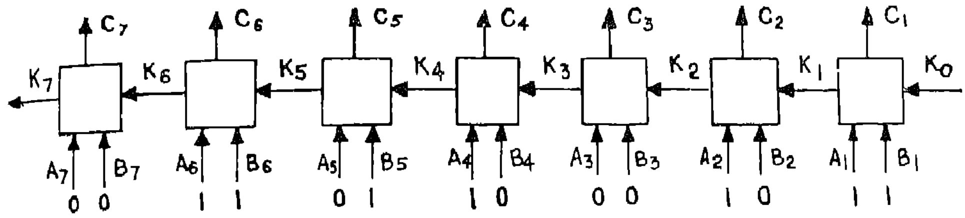

Fig. 6

The summator gives us the result 1011100. If we need to add the binary numbers consisting of more digits we have to construct a compound summator with the corresponding number of elements in the summator.

Fluorine—the Fire-brand Element

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Introduction

AFTER recognising the elementary nature of chlorine in 1810 Davy started electrolysing aqueous solution of hydrofluoric acid in vessels of sulphur, carbon, gold and platinum but succeeded only in decomposing water. Faraday studied the electrolysis of molten fluorides, but could not succeed in isolating fluorine. It was the experiments with mixtures of anhydrous hydrogen fluoride and potassium fluoride that led to the isolation of elemental fluorine by Moissan in June 1886. [Moissan, H. Compt. rend. 102 (1886) 1543]. His apparatus consisted of a small platinum 'U' tube which was partly filled with the electrolyte and was cooled externally by a bath of boiling methyl chloride. A platinum electrode was inserted into each arm of the tube.

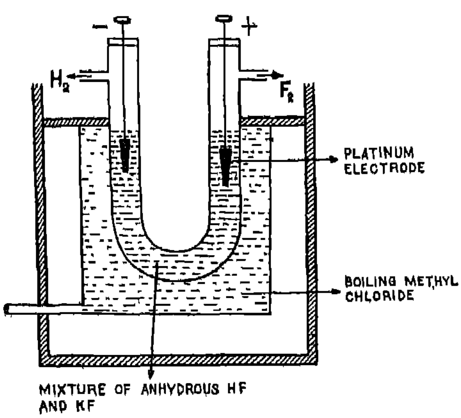

Fig. 1

Up till World War I, no major change in the above method was made. It was in 1919 that Anderson found that [Trans. Electro. Chem. Soc. 35 (1919) 335] fluorine could be set free at above 250°C from a graphite electrode by electrolysis of the liquid obtained by melting the potassium acid fluoride.

Lebean and Davie [Compt. rend 181 (1920) 917] obtained fluorine at a nickel anode operating at about 100°C in an electrolyte containing about 2-3 moles of HF per mole of KF.

Mathers and Stroup [Trans. Electro. Chem. Soc. 66 (1934) 245] developed a cell capable of operation at room temperature with a low melting electrolyte of acid fluoride.

Little was known about this most reactive element before World War I. Had the atom bomb not been made for World War II, it might have remained still a scientific novelty. Though its source, the blue-green mineral called fluorspar had long been used for making metals and glass, it was the element fluorine which was needed to purify uranium required for the atomic bomb and it was needed in large quantities.

In war time, cost is not a consideration. Compared to the total cost of the Manhattan project, the cost of manufacturing fluorine, a few tonnes a day was almost nothing. The object was to separate U^{235} from the more abundant but less desirable U^{238} by a process of vapour diffusion of Uranium hexafluoride (UF_6). This compound was obtained from the reaction of UO_2 with HF to produce UF_4, which was then treated with fluorine to obtain UF_6.

TABLE I

Physical properties of halogens

	F_2	Cl_2	Br_2	I_2	Argon
m.p. °C	—218	—101.6	—7.0	+114.0	—189.2
b.p. °C	—188	—346	+59 0	+184	—185.7
Heat of fusion (cal/mole)	382	1615	253	3740	268
Heat of vaporisation (cal/mole)	1581	4420	754	14880	150
Gas viscosity x 10	2093	1297	1900	1785	2096

It is obvious that fluorine is very different from chlorine and that in many ways, its physical properties closely resemble those of argon

Fluorine is unique among the chemical elements in the wide range of compounds, that it is able to form. Exciting new developments in fluorine compounds have been reported during the last decade or so.

Three main factors explain the unusual properties of fluorine.

1. The low dissociation energy of the fluorine molecule.
2. The relatively high strength of bonds formed between fluorine and other elements.
3. The relatively small size of the fluorine atom and the fluoride ion.

Perhaps, the most important property of fluorine responsible for its high reactivity is its low dissociation energy (37 kcal/mole). Compare it with the dissociation energy for oxygen (110 kcal/mole) or nitrogen (225 kcal/mole) respectively, large electron-electron repulsion in the fluorine is responsible for its low bond dissociation energy. Most of the materials can burn in it, producing corresponding fluorine compounds. As is clear from Table II, the extent of dissociation at constant temperature decreases from iodine to chlorine but fluorine is dissociated about as much as iodine (see bond energy).

TABLE II

Some properties of halogen elements

	F	Cl	Br	I
Electron affinity (kcal/mole)	82 1	86 6	82 6	71.0
Ionisation potential (kcal/mole)	402	300	273	241
Electronegativity (Pauling)[1]	4.0	3.0	2.8	2.5
Covalent radii (A°) (Sanderson)[2]	0.71	0.99	1 14	1.33
Ionic (A°)	1.36	1.81	1.95	2.16
X-X Bond energy (kcal/mole)	37 8	58 2	46.1	36 1
Boiling point (°K)	85	239	332	460

1. Pauling, L *Nature of the Chemical Bond*, Connell Univ Press, N Y , 1960.
2. Sanderson, T. *Chemical Periodicity*, Reinhold, N. Y., 1960.

When fluorine is reacted with hydrogen, tremendous energy is released. The specific impulse of the reaction

$$H_2+F_2 \rightarrow 2HF$$

is about 400 sec. Hydrogen-fluorine motors are now being designed in U.S A.

To understand fully the high reactivity of fluorine one may look at some of the atomic properties of the element fluorine.

The first such property is electronegativity which is a combination of electron affinity and ionisation potential It reflects the ability of an element to attract electrons and form a chemical bond. Fluorine has the highest electronegativity value, i.e , it has the greatest ability to form a stable bond. Even the inert gases, xenon and krypton form compounds with it (XeF_4, XeF_6, etc.). It is mainly the variation in ionization potential which is reflected in the electronegativity value. Electron affinity, which measures the tendency to form univalent negative ions, varies little among the four elements. Although the basis for assigning numerical values for electronegativity may be a matter for discussion, the concept itself is of utmost value.

The second property is its smallest radius. This combined with a very low degree of polarisation makes fluorine retain its electronic shape in a chemical bond.

By incorporating fluorine in the molecular structure of everyday materials, we can develop in them many desirable properties, such as resistance to corrosion, indifference to heat and immunisation against atmospheric and other influences. Certain metals such as copper and nickel can be used to contain elementary fluorine only because protective layers of metal fluoride, which prevent further action on their surface

Some of the well-known modern compounds of fluorine are:

1. (*a*) *Freons :* Everyone living in cities, at least, is familiar with freons, the liquids used in refrigerators as heat exchangers. Freon can carry heat from one place to the other almost indefinitely without decomposing and without clogging or corroding the pipes. To add to these advantages is the fact that they are inflammable.

Not only as heat exchangers, but also as lubricants, they are almost unique. Whereas, the ordinary lubricating oil will carbonise and char in a motor car engine, freons do the job without ever worrying about the heat

1. (*b*) *Fluons* : Plastics—the synthetic polymers, though versatile in their properties, are inherently susceptible to effects of temperature. When fluorine is incorporated in their molecular structure, their susceptibility to heat just disappears. It brings to them inertness and yet the product can be moulded into any shape. Hexafluorobenzene (C_6F_6) and perfluorocyclobutane (C_4F_8) are stable up to a temperature of 600°C.

Nothing has been found that will dissolve fluons. Even aqua regia, the acid that can dissolve gold and platinum, has no effect on this amazing plastic. Articles made from it maintain their shape for months at temperatures up to 3000°C. It is an excellent material for modern electrical industries because of its exceptional insulating properties against high frequency currents

Space rocket research is making use of fluorine plastics to an appreciable extent

2. *Liquid Fluorine* : (B.P.—188°C). For a substance of its molecular weight, the boiling point is very low. It can replace liquid oxygen as a rocket propellant, the only difficulty is its storage below —180°C. But with modern materials, techniques for its storage have been developed. The colour of liquid fluorine is "canary yellow." Its odour is very characteristic and intense It can be detected even when present in traces. Its surface tension is very low (9.8 dynes/cm) at 85° K.

Fluoro-carbons

The systematic study of fluoro-carbons dates from 1937 when Simons and Black made the very interesting discovery that reaction of fluorine with carbon which is normally difficult to control, proceeds more smoothly when carbon is impregnated with a mercury salt, which presumably is rapidly converted to mercury fluoride.

When fluorine is passed through graphite at 420-460°C, a grey hydrophobic material is obtained.

The above reaction is catalysed by hydrofluoric acid. It is because of this reason that graphite electrodes used in the electrolysis of KHF_2 for the preparation of fluorine rapidly disintegrate.

The loss of electrical conductivity by graphite on reaction with fluorine is due to the disappearance of plane layers present in graphite. Instead, we get puckered layers of carbon with distance between the layers of 6.6A° instead of the usual 3.35 A°.

Substitution of fluorine for hydrogen in an organic molecule imparts to the latter certain unique properties. Because of the small size of radius and a low degree of polarization, the C-F bond has a very high dissociation energy. Consequently, the intermolecular forces will be weak or in other words, the fluoro-carbons will be having a low boiling point almost in the same range as the corresponding hydro-carbons.

Another consequence of the low polarisability is a low refractive index. In fact, refractive indices of fluoro-carbons are less than those of any other class of compounds.

Their insolubility in common solvents like methanol, benzene, etc. makes them quite useful in polymers.

Yet another property, which has increased the utility of fluoro-carbons as industrial material, is their low surface tension. A surface composed of closely packed CF_3 groups has a very low surface energy (6 dynes/cm). When applied to cotton fibre, makes it water-repellent. Another advantage of the low surface tension of fluoro-compounds is their ability to defoam organic solvents. Low surface tension makes large bubbles mechanically unstable thereby making it impossible to form foams. Because of a combination of so many desirable properties like inertness, low toxicity, low flammability, high thermal stability, the commercial importance of fluoro-carbons is increasing. They have a steady flourishing market.

Fluoro-aerosols

Aerosols were first used in the bug-bombs of World War II and due to the popularity of the principles, now find use as propellants in a wide variety of products for household and personal applications. Recently, a new fluoro-carbon (octa-fluoro-cyclo-butane) has been approved as a food aerosol.

Fluoro-rubbers

Perhaps the most striking property of fluoro-rubbers is their resistance to swelling in gasoline, jet fuels, hydraulic oils and many aromatic and chlorinated hydro-carbons used industrially. The only drawback is the "stiffening" nature of the C-F bond which makes the product brittle and unstable at low temperatures. But when fluoro-substitution is effected in a silicone, one gets the usual advantages of fluorine substitution added to the inherent flexibility of silicone structure.

As a result of this stiffening effect of the C-F bond, the change of viscosity with temperature is rather large. This limits the application of fluoro-rubbers as hydraulic fluids and jet-engine lubricants, where a rigid control of viscosity is desired. It has been recognised for many years that an element tends to exhibit its highest oxidation state when in combination with fluorine. This is true not only for metals, but other halogens also, for example,

compounds like ClF_3, ClF_5, IF_7. Most of these inter-halogen compounds are comparatively volatile

Oxygen fluorides

The fluorides of oxygen are of topical interest both in connection with their possible use in high energy propellant mixtures and because of their reactions and structures.

Fluoro-chemicals as water-repellents

All fluoro-chemicals do not give water-repellent effects when applied to textile material but certain types such as those based on chromium complexes of saturated per fluoro alkyl monocarboxylic and various fluorinated acrylic and methacrylic esters do confer water repellency. They are unique in another aspect also; they give oil repellency without coating the fabric. But at the present moment the cost for using them is prohibitive.

In fluorine chemistry, quite often there is a challenge in the experimental side itself. It is always worth doing the experiment. It may not yield the expected result, but when such a reactive element is involved, something will almost certainly happen and this is often the way in which important discoveries are made.

Environmental Conservation Education: Three Approaches to its Introduction in School Curricula

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THE urgent necessity to introduce environmental conservation education in school is beyond doubt. The basic principles and ideas on this are fairly well developed. The question now is how to introduce this without great disturbance to the existing structure of education. For this purpose:

(*a*) a comprehensive school curriculum for environmental conservation education has to be developed;

(*b*) this curriculum should be suitable and acceptable in terms of space and duration within the overall time available for instructions in schools.

Various approaches to the solution of these problems have been suggested before. They can be roughly grouped into three kinds:

(1) Topics on environmental education may be dispersed through the entire or major part of the curricula by certain insertions in the syllabi of various disciplines.

(2) A specially designed Nature Conservation Unit may be a chapter or section within the framework of one of the existing school subjects.

(3) An integrated course of environmental conservation education as a separate discipline co-equal to other school subjects.

Each of the above approaches has its advantages and disadvantages, the general conclusion being that the more valuable and attractive the proposals for introducing the entire environmental conservation concept, the more difficult seems to be the task of implementation within the school curricula. This is quite understandable in view of the already overstrained instructional time in the school and also the over-loaded curricula.

The integrated approach is very popular. No doubt this approach is the best way to form the whole idea of environment and make the younger generations aware of it. However, its immediate implementation requires at least 30 school hours (if one period a week is the minimum). Where can we get this hour ? None of the school subjects can be forced to yield this hour in favour of a new subject within the existing time limit. On the other hand nothing can be added smoothly to the present 30 to 36 hours per week of the school time.

As for the "topics" approach, specialists in each field can easily find a little space within the respective syllabi for definite insertions which concerns both environmental conservation and the particular subject This approach however does not allow any opportunity to integrate those topics and to turn them into an environmental philosophy.

The "chapter" or "unit" approach is an obvious compromise between the two. As with any compromise, it combines the advantages

and the disadvantages of both the integrated and topics approach. Obviously the conservation chapter should be in line with the subject in which it is included. This would mean certain limitations to the content of the chapter or unit. For instance some social or technological aspects of environmental conservation will look unnatural inside the biology syllabus and *vice versa.* Nevertheless, the advantages of this approach outweigh its disadvantages. Experience has shown us that it is possible to set aside 12 to 16 periods (school hours) for environmental conservation chapter within the biology or geography syllabi of the schools mainly by re-arranging and omitting some descriptive material. This time is relatively sufficient for presenting the chief aspects as well as the integrated idea of environmental conservation. If this is accompanied by a number of environmental topics incorporated into this and other disciplines such a combined approach is good enough to achieve the basic objectives of environmental conservation education in schools.

For the reasons stated above we treat these three approaches as successive stages rather than alternatives in the implementation of the introduction of environmental conservation education in the school curricula

In our view the time is ripe to concentrate efforts on introducing the second stage namely the "chapter" or "unit" approach mainly into biology and geography curricula. Firstly, it is much easier under the existing circumstances to achieve a partial revision of these syllabi than to carry out an all-round reform of school curricula as a whole. Secondly, there are practically no biologists or geographers including curriculum makers who object to incorporation of environmental conservation into their subjects. Thirdly, this stage preceded by the dispersion of environmental topics in many subjects in fact provides a good opportunity to sum up this scattered knowledge into a coherent whole.

The most complete "integrated" approach should be considered the third and final stage of implementation of school environmental conservation education We do not think that favourable circumstances for its immediate introduction into school curricula exist in many countries for reasons mentioned above. It does not mean that the working out of this integrated curriculum for environmental conservation should be given up On the contrary such a syllabus should be ready for implementation as soon as circumstances allow it. Moreover, such a situation may develop even now in some developing countries especially in those in which new school curricula are being designed or completely revised.

Our favouring the "unit" approach reflects our own experience In the course of development of new science curricula for Indian schools it was this approach which was chosen to introduce the environmental conservation concepts. It is a natural follow up (and this is combined) with the environmental topics and elements taken up in the course of general science (primary science), biology, geography, chemistry, etc. In other words the latter are crowned by a special chapter "Conservation of Nature" within the first part of biology syllabus for the High/Higher Secondary School (class 9, age group 14-15).* This

*At present in Delhi and some States of India the 11-year school educational pattern consists of the primary (classes 1—5, 5 + to 10 + age group), middle (classes 6—8, age group 11 + to 13 +) and higher secondary school (classes 9—11, age group 14 + to 16 +). In other States the 10-year school pattern is established. Teaching of science as separate disciplines (physics, chemistry, biology, etc.), is running through middle and secondary schools. For instance biology is taught for 6 years (3 periods a week, totally about 500 periods). In class 9 biology course is mostly devoted to ecology Therefore, the chapter "conservation of nature" is preceded by divisions like "Population", "Biocenosis" and "Biosphere".

chapter involves 16 periods (school hours) or some 20 per cent of the class 9 biology curriculum. It contains the following main themes: "vital importance of conservation of nature for the existence of life", "management of natural resources in a rational way", "conservation of atmospheric air, water resources and soil", "the global role of the green cover", "protection of wild life", "national and international efforts for effectiveness of environmental conservation", etc.

The new science curriculum, including environmental conservation in the above mentioned form is, being introduced on an experimental basis in all States and Union Territories of India, under the Secondary Science Teaching Project.

Mineral Processing

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METALS form a very important class of materials in modern society. Their uses in day-to-day life both domestic as well as industrial are too numerous to be listed in brief. Many of these are very familiar to us and probably do not require to be emphasized.

As everybody knows, materials occur in nature in the form of certain chemical compounds. These naturally occurring chemical compounds are called minerals For example, iron occurs in chemical combination with oxygen in a mineral called hematite which is iron oxide of chemical formula Fe_2O_3. Likewise copper occurs in combination with sulphur; one of the principal minerals is called chalcocite with chemical formula Cu_2S The metal has to be isolated from the mineral by chemical treatment which usually involves roasting in a blast furnace followed by reduction of oxide formed to the metallic state.

The natural compounds referred to as minerals do not always occur in the pure state. Quite often they are associated with sand and other worthless matter commonly called gangue. The rock in which the mineral occurs (along with gangue matter) is called an ore body or ore deposit. The percentage of the economic mineral which is sought for the extraction of metal varies from one deposit to another. There are very few regions where high grade deposits, the ores in which the percentage of economic mineral is very high, are found. As the modern society consumes metals at a very fast rate, the high grade deposits are rapidly getting exhausted. Man has therefore to exploit the numerous low grade deposits to meet his requirements

It is not possible to treat the low grade deposits directly for isolating the metal. It is necessary to separate the economic mineral from the gangue matter. This is for two main reasons. Firstly, the presence of a large mass of gangue matter results in large consumption of fuel in the blast furnace; obviously this is a wastage Secondly, if th low grade deposit is directly subjected to chemical treatment it is likely to yield a complex molten mass from which it would be very cumbersome to recover pure metal. For these reasons the desired mineral has to be separated from gangue before subjecting it t chemical treatment for the isolation of ele ment. This step is called mineral processing It is also referred to as ore dressing or miner beneficiation in modern literature.

Several techniques have been develope for mineral processing. Many of these a based on certain characteristic physical pro perty of a mineral by which it is distinguis ed from the gangue matter. Methods bas upon specific gravity, magnetic proper and surface property are in use and will described in this article.

Ore Treatment

A preliminary step in all mineral proce ing is powdering the ore body to the desir degree of fineness. This is done by cru ing the ore to small bits followed by grindi of these bits to powder form. Grindin done in machines called ball mills. In th

the ore is constantly rubbed against porcelain balls by mechanical agitation. This results in progressive grinding of the ore. Grinding is continued until the desired particle size is reached. The object of grinding is two-fold. Firstly, the particles must be sufficiently light; secondly, the particles of the mineral must be distinctly separated from those of the gangue. This is known as liberation. If liberation is not satisfactory, the gangue will be carried along with the mineral in the subsequent step in processing since the two are interlocked in the ore grain. Separation of mineral from the gangue will not be achieved. For this reason, before the processing technique the ore body must be ground sufficiently well. The extent of liberation of the mineral and the ganuge particles can be observed by examining a sample of the ground ore under a microscope. The time of grinding is adjusted such that just the satisfactory degree of liberation is reached. Grinding should not be carried beyond this stage because the ore particles would be too fine to be handled by the processing techniques.

We shall now consider some of the widely employed methods of mineral processing.

Gravity Separation

One of the methods which has been in use for more than a century is based upon separating the two constituents of an ore body taking advantage of the difference in specific gravity between the two constituents.

One of the techniques based on this principle is called jigging. This is applicable when there is appreciable difference in the densities of the two constituents. For example, galena (lead sulphide) which has a density of 7.5 gm/cc can be separated from quartz (gangue matter) which has a density of 2.7 gm/cc. When the particles of these two fall freely in water they have different velocities, the heavier particles falling at faster rate. In order to bring out better separation the particles are made to fall in a rising stream of water. Under this condition the velocity of galena is reduced from 260 mm/sec. to 110 mm/sec. On the other hand, quartz particles of equal size which fall at a velocity of 96 mm/sec. would have their velocity altered to the negative direction by a stream of water rising at a speed of 150 mm/sec. Instead of falling they now rise at a speed of 54 mm/sec. This differential settling can thus be used to make these particles pursue opposed paths thus bringing out a good separation.

In actual practice of jigging, water is pulsed strongly upward and downward through a bed of particles so that they alternately become water borne and settle. This is done by filling the ore particles in an ore box which is then pushed up and down through a tank of water. The operation is continued until the particles assemble themselves with the lightest above and the heaviest below.

This method essentially exploits the difference in density between particles of similar size. The process is mostly suitable for ores which are adequately liberated at a fairly coarse level of grinding. It is widely used in beneficiating coal, iron, barytes ($BaSO_4$), galena (PbS) zinc blende (ZnS) and fluorite (CaF_2). However, a large body of ores mined today usually require fine grinding and are, therefore, unsuitable for jigging.

Another method closely related to the one just described makes use of the separation of particles in streaming currents of water. A sheet of water flowing down a slope acts as the principal agent in separating the constituents of the ore. This method, also dependent upon the significant differences in densities of the constituents is called film sizing. The appliances used to separate

heavy minerals from relatively light depend mainly upon the work done by water as it encounters ore particles while flowing down an inclined plane. This plane may be smooth or rough; gently or steeply inclined; stationary or mobile. Instead of a plane, concave or convex surfaces may be used. The flow of water may be quite or intermittent. When a number of special particles roll down a lightly tilted plane the largest spheres travel fastest and the smallest ones slowest. Of two spheres having the same density the larger moves faster. Of two having the same diameter, if the slope is relatively gentle the lighter sphere travels faster. Now if the whole plane is moved sideways, the spheres are subject to a horizontal displacement which varies in accordance with the length of the time they take to roll down. The net result of all these is that the original mineral feed spreads into bands according to the size and density of its constituent particles. The feed will have segregated into three main products: fastest moving consisting of coarse light particles essentially those of the gangue; medium moving comprising fine light mineral and coarse heavy mineral; and the slowest moving consisting of fine heavy particles essentially those of the economic mineral which has considerably higher density than that of the gangue. The separation of the three fractions will not be good enough in a smooth plane. In order to get improved separation the plane is divided into narrow pockets by employing partitions which allow the flow of water in a direction right angle to their length, but retain the mineral particles settling in them. These are called riffles. The particles settling in the pockets provided by different riffles will follow the pattern given above. It is, therefore, possible to collect the settled particles consisting of the constituents separated in accordance with their densities and degree of fineness. This technique employing a plane consisting of a number of riffles is called tabling. It is particularly employed in the processing of gold, separating the gold particles from the associated quartz, advantage being taken of the considerably high density of gold.

Heavy Media Separation : An extension of gravity method involves the use of a dense liquid, the density of which is in between those of the two constituents desired to be separated. If a fluid of suitably high density can be maintained in a sufficiently quiet and stable condition the relatively heavy particles fed into it sink while the light ones float. A medium of high specific gravity may be produced by the use of organic liquids of high density, solutions of salt or suspensions of slow settling solids in water. In some places mixtures of liquids are used to get a medium of desired density. Tetrabromoethane ($C_2H_2Br_4$, specific gravity 2.17), ethylene dibromide ($C_2H_4Br_2$, specific gravity 2 17), pentachloroethane (C_2HCL_5, specific gravity, 1.68), trichloroethylene (C_2HCL_3, specific gravity 1 46) are the typical examples. These are employed for the beneficiation of coal. The method has been extended in recent years for the beneficiation of medium grade manganese ores in which pyrolusite (MnO_2) is the principal constituent. The organic liquids suffer from the disadvantage of being highly expensive. They have been replaced by a concentrated solution of calcium chloride of specific gravity 1.35. Another variation introduced is the application of very finely divided solids suspended in water. A mixture of clay, finely ground barytes ($BaSO_4$) mixed in a ratio of 2:1 can be diluted with water to any desired density up to 1.8 gm/cc. When media of higher densities are required, magnetite (Fe_3O_4) or galena could be used. In modern times ferrosilicon is the most widely used substance. A 15% ferrosilicon can

be used to produce heavy media with specific gravities up to 3.5.

Magnetic Separation

When a particle is placed in a magnetic field it either attracts or repels the flux flowing between the magnetic poles. A substance is said to be paramagnetic when it concentrates lines of force to reach a flux density greater than unity and diamagnetic when it repels lines of force. Paramagnetic substances are attracted towards regions of greater flux density while diamagnetics are repelled. When paramagnetism is strong it is called ferromagnetism. This property is exploited for the concentration of certain minerals. Diamagnetic forces are too feeble to be of use in mineral processing, and minerals responding to these and those with feebly paramagnetic properties are classified under nonmagnetic minerals. Strongly and weakly magnetic minerals are differentiated into separate products. The strongly magnetic particles are deflected from the others in a moving steam of material.

For the purpose of magnetic separation, minerals are differentiated from each other by their magnetic susceptibilities which is the ratio of intensity of magnetisation to the strength of the magnetic field. When maximum magnetisation is reached the particle is said to be saturated. At moderate field strength all ferromagnetic minerals become saturated These include mainly iron minerals like magnetic pyrrhotite (FeS), magnetopyrite (FeS_2), ferrosilicon (Fe_3Si) and magnetite (Fe_3O_4). Minerals of low magnetic susceptibilities can be processed by employing strong fields (up to 20,000 gauss) produced by powerful electromagnets. Among the ores which may be directly concentrated by magnetism are franklinite ($Fe_3Mn_3ZnO_4$), ilmenite ($FeTiO_3$) and wolframite besides the ferromagnetic minerals just mentioned.

In actual practice a non-magnetic drum is made to rotate above a series of oppositely charged magnets. The mineral particles are fed to pass round the drum The magnetic lines of force grip the ferromagnetic minerals which roll with each change in polarity till they are pulled clear of the free-falling non-magnetic constituent (gangue).

Froth Flotation

The method of froth flotation is a very useful technique especially valuable for the beneficiation of low grade ores containing sometimes as low as 1-2% economic mineral. This method essentially consists in making the mineral particles float at the surface of water while the gangue matter sinks.

In general, all the metallic compounds have densities greater than that of water and as such they cannot by themselves float at the surface of water. In order to make them float, use is made of the fact that when properly conditioned, mineral particles get themselves attached to air bubbles and are thereby carried to the surface.

The process of flotation, therefore, requires the production of air bubbles in water and conditioning the mineral particles in such a way as to make them get attached to air bubbles. When air bubbles are blown in ordinary water they collapse as soon as they are formed. For the success of the flotation of minerals, they should persist for a fair length of time so as to allow the mineral particles to come in contact with them. For the stabilization of air bubbles certain reagents known as frothers are employed. On account of this the process is known as froth flotation.

What is the characteristic of a frother and what brings out stabilization of air bubbles in their presence? The frother mole-

cule essentially contains two groups referred to as polar group and non-polar group. The entire molecule is known as the one possessing heteropolar structure. A very simple example of heteropolar molecule is alcohol, C_2H_5OH. In this the hydrocarbon group $—C_2H_5$ is the non-polar group. The property of such a group is that it does not mix with water. All hydrocarbons are immiscible with water; this property is reflected in the lack of affinity of hydrocarbon group to water which is due to its chemical nature. On the other hand the —OH group has an affinity for water which is due to its chemical nature. A study of the electronic structure has shown that —OH group resembles water and hence it can mix with it whereas a hydrocarbon group has a structure incompatible with that of water and the two do not mix. Besides —OH group certain other groups like carboxyl (—COOH), ketonic (—CO), aldehyde (—CHO) or ester (—COÖ) also possess polar nature.

When a compound possessing such heteropolar structure is added to water it tends to concentrate at the surface. The surface is better referred to as air-water interface. By accumulating at the air-water interface the molecule is able to satisfy its affinity for water, due to the presence of polar group as well as the lack of affinity of the non-polar group for water. When a group has no affinity for air it tends to get away from it and go towards air. Thus, the frother molecules tend to concentrate at the air-water interface provided by the air bubbles being blown into water, thereby serving as a link between air and water. This results in the persistence of air bubbles in water for a fair length of time.

Typical frothers employed in flotation process are pine oil, eucalyptus oil, cresylic acid which are all pleasant smelling organic compounds possessing heteropolar structure and having fair solubility in water.

The second essential requisite for mineral flotation is conditioning the mineral particles in such a way as to make them air avid. This is achieved by the application of another class of flotation reagents called mineral collectors. These are generally water soluble chemical compounds which also possess heteropolar structure comprising a hydrocarbon group and a polar group. The primary difference between a frother molecule and a collector molecule is that the polar group of the frother molecule has an affinity for water while that of the collector molecule has an affinity for a specific mineral surface. When the mineral is treated with such a reagent, it acquires a thin film on its surface. This is something like a film of oil which is not wetted by water. This non-wettability is due to the hydrocarbon group present. The mineral acquires such a film because of the presence in the collector of polar group having an affinity for the mineral. When the mineral acquires such a film called hydrophobic or water repellent (meaning thereby that it gets repelled away from water) film, it becomes air avid. Its surface is not wetted by water and consequently it gets attached to air bubbles.

The flotation due to the hydrophobic film can be demonstrated by means of a thin zinc plate. If the clean plate is put at the surface of water it immediately sinks due to its greater density. Now if its surface is thinly smeared with grease and then the plate is kept on water with the greasy side in contact with water surface, the plate floats since water is not able to wet the surface.

The specificity of a collector towards a mineral is an important factor in the separation of the mineral by froth flota-

tion. The fact that a particular collector 'A' forms a hydrophobic surface at a certain mineral 'B' and not at silica surface enables the separation of 'B' from the associated sand. The reasons for the specificity of collectors to minerals are not fully understood in all cases. It is partly due to chemical interaction between the collector and the atoms present at the mineral surface and partly due to the uptake of collector molecule at the mineral surface due to physical forces of attraction, a phenomenon known as physical adsorption.

Commonly employed collectors are potassium xanthates having the general formula

$$C_nH_{2n+1}OC(=S)—S^-K^+;$$

Potassium ethyl xanthate is mostly employed. These are specific for sulphide minerals like galena (PbS), chalcopyrite ($CuFeS_2$), zinc blende (ZnS) and the like. For oxide minerals (like hematite) long chain fatty acids (possessing a carboxylic group) like stearic acid, oleic acid and caproic acid are found effective collectors. Long chain mines like dodecylamine are also used for these minerals. In recent times several complexing agents which are known to form complex compunds with certain metals are coming into use as mineral collectors.

The method of froth flotation is also useful in separating two or more minerals present in the same ore body This is done by introducing certain modifying agents in the process. Such modifying agents are broadly classified under two names, activators and depressants. A depressant is a reagent which prevents the flotation of a mineral by a collector that would otherwise float the mineral. The most common depressant is any alkali. On increasing the concentration of alkali the hydroxyl ions generated prevent the action of collector at the mineral surface. The concentration of alkali required for depression varies from mineral to mineral. By controlling the concentration of the alkali it is possible to bring out selective flotation of one of the minerals. For example, from an ore body containing pyrite (FeS_2) and chalcopyrite, it is possible to float chalcopyrite by raising the pH to about 8.5. At this pH the collector used (xanthate) will not be able to act on pyrite which is thus depressed. The principle here is that while chalcopyrite can tolerate hydroxyl ion concentration even up to pH 10 (above this that too gets depressed) pyrite gets depressed when the hydroxyl ion concentration goes beyond pH 7 5. This principle is followed in the beneficiation of chalcopyrite from ore deposits found in Ghatsila in Bihar State.

The function of an activator is opposite to that of a depressant. By its presence, an activator facilitates the action of a collector at a mineral surface which would otherwise not respond to the collector. It may also function by neutralizing the previous action of a depressant. Activators are generally inorganic substances and they too are useful in the selective flotation of different minerals present in the same ore body.

One of the well-known examples of selective separation of minerals by froth flotation method is found in the beneficiation of lead-zinc ore occurring at Zawar in Rajasthan State. The ore body contains about 5—6 per cent galena (PbS), 5—6 per cent zinc blende (ZnS) and 1—2 per cent pyrite (FeS_2) besides a large percentage of silica gangue. The powdered mineral is subjected to flotation

in presence of lime and potassium cyanide used as depressants, potassium ethyl xanthate as collector and a frother. The quantities of lime and cyanide are so controlled as to bring out the depression of pyrite and zinc blende Under these conditions only galena floats. After separating galena, the remaining pulp is activated with cupric sulphate which serves as an activator for zinc blende. Thus, flotation of zinc blende is brought out after the flotation of galena. A satisfactorily clean separation of the two minerals is thus achieved.

In modern times, highly complex ores containing a large number of minerals are processed by froth flotation. The process generally involves application of different modifying agents, varying the nature and concentration of reagents suitable for different minerals. This, together with the fact that flotation is particularly suitable for the concentration of very low grade ores has made it a most important process in mineral technology.

Various new techniques of mineral processing are constantly being developed. Most of these are dependent on specific physical properties some of which were mentioned in this article There are also methods involving chemical treatment of the mineral. These chemical methods also form a very important branch of mineral processing known as hydrometallurgy. It is proposed to describe these in a separate article.

Medicinal Values of Indian Grasses

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THE MEDICINES are the most important things for establishing happy human society. Their main source is plants. The grasses are a group of plants having complete domination over animal life. Domestic animals get their food in the form of fodder from grasses. We get food from wheat, barley, etc.; sugar from sugarcane; paper from Bansi, Saccharum sp. etc; essential oil from lemon grasses and ornamental plants and so on from grasses. The main grasses of India having medicinal values are listed below.

1. Agropyron repens (Linn.) P. Baeuv

The plant with long creeping underground rhizome, is mostly found in Kashmir and adjoining areas.

The rhizome of the plant contains triticin, dextrose, mucilage, mannitol and inositol. It is demulcent, diuretic and is used internally in the treatment of catarrhal diseases of genito-urinary tract in the form of liquid extract or decoction. The decoction is a suitable vehicle for bladder sedatives and antiseptic. This grass has succeded in achieving place in a recognised Indian pharmacopoea.

2. Arundo donax Linn.

It is a tall perennial ornamental grass having long drooping and tapering leaves. Commonly it is called 'Bara nal' in Hindi and 'Spannish cane', 'Giant reed grass' in English.

A decoction of the rhizome is said to stimulate menstrual discharges and diminish the secretion of milk. It is also consumed in the manufacture of musical pipes (Bansuri), walking sticks, fishing rods, etc.

Plant of Wheat, a well-known source of food and medicines.

3. Cymbopogon citratus. (DC) Stapf

The grass is cultivated throughout the country for its economic value. In Hindi it is commonly known as 'Sugandh', 'Aghyaghas' and in English as 'West Lemon Grass'.

The oil obtained by distillation is well-known lemon-oil. The leaf buds of the plant are sold in market as a flavour for curries, The plant is good laxative and used as

anthelmintic. The sufferer from bronchitis, epileptic fits and leprosy are said to be benefited by drinking infusion of the plant. The oil is said to be an excellent embrocation for chronic rheumatism, sprains and neuralgia. The infusion of its leaves is taken as a substitute for tea as a refreshing beverage.

Cymbopogon flexuosus (Nees) Wats

The grass is mostly found in Tamil Nadu as well as in northern parts of the country as a wild species. It is commonly called 'East Indian Lemon Grass'.

This grass is the source of valuable aromatic oil known as oil of lemon grass which is a source of vitamin A. The oil is also used in cosmetics and perfumery.

Cymbopogon Jwarancusa (Jones) Schult

This grass is very common in northern, eastern and western parts of the country.

The grass is well-known as a febrifuge and has obtained its common name 'fever arrester' from this very characteristic. The grass is also used as a stimulant and as a sudorific in gout and rheumatism The oil smells like peppermint.

Cymbopogon Martinii (Roxb.) Watson

The grass is very common in all parts of the country except southern parts. It is commonly known as 'Mirachganda', 'Gandhejghas' in Hindi and 'Ginger Grass' in English. The plant is found in two varieties 'Motia' and 'Sofia' called by local.

'Motia' is a source of valuable palmrosa oil while 'Sofia' is a source of ginger-grass oil which contains large quantity of geraniol. The oil of the grass is useful on lumbago, baldness and in skin diseases. It is also taken internally in billious complaints. The oil is recommended in mosquito repellent ointments. The aromatic oil is used in perfumery and cosmetics.

Cymbopogon nardus (Linn) Rendle

The grass is distributed widely in southern and eastern parts of the country. The species is also cultivated in some southern parts for its valuable citronella oil. The grass is commonly known as 'Ganjani' in Hindi and 'Citronella Grass' in English.

The infusion of the grass is utilized as stomachic and carminative. The oil is consumed in the preparation of insect repellent ointment and as perfumery in cosmetics.

Cymbopogon schoenanthus (Linn.) Spreng

The grass is distributed in the western and southern parts of the country specially in dry areas. It is commonly called 'Rousaghas' in Hindi and 'Camel Grass' in English.

The infusion of the grass is used as a stomachic and the oil is useful in rheumatism. The decoction of the plant is given as febrifuge. Beside its diuretic value it is also said to promote the dissolution of stones in the bladder. The oil is very much useful in various diseases varying from gout, fever, cholera, coughs, leprosy, indigestion and haemorrhages.

4. Desmostachya bipinnat (Linn.) Stapf

This perennial tall grass is very common in desert and semidesert areas such as fallow fields, etc., throughout the country. Commonly it is known as 'Daab', 'Durva' and 'Kusa.'

The plant is utilized as an ingredient of medicines in dysentery and menorrhagia. It is also useful in diuretic.

5. Hordeum vulgare Linn.

An annual herb cultivated as food crop in North India. Commonly it is known as 'Jau' in Hindi while as 'Barley' in English.

The seeds are demulcent, easy to digest and are used in dietary of sick. Parched and

powdered grains are largely used in the form of a gruel in cases of painful and atomic dyspepsia The extract has become extremely popular both as a nutritive and demulcent, and as a means for rendering other medicines palatable.

6. **Oryza sativa Linn.**

This grass is cultivated all over the country as a food crop in rainy season. It is commonly known as 'Dhan' and without husk as 'Chaval' In English it is called 'paddy' and without husk as 'rice'.

The seeds are cooked and eaten in place of bread. The rice gruel is very useful in disturbed digestion, bowel complaints, diarrhoea and dysentery. The rice-water is refrigerant and forms a soothing and nourishing drink in febrile diseases and inflammatory states of intestines. It is also utilized in the form of poultice, like linseed meal poultice. The rice-bran oil is used for soaps and cosmetics and as an anticorrosion oil.

7. **Panicum antidotale Retz**

This is a tall, glabrous, perennial grass often found on sand dunes, in the dry bed of rivers and in deserted places throughout the country. In Hindi it is called 'Bansi', 'Gunnara' and 'Bansil'.

The smoke of the burning plant is recommended as a good medicine for fumigating wounds and as a disinfectant in smallpox This fodder grass is also consumed for the fixation and reclamation of sand dunes.

Panicum miliaceum Linn.

This grass found in the dry parts of north-west India is a hot weather crop. In Hindi it is known as 'Chin', 'Anu' and 'Common millet' in English.

The plant extract is used as a cure for gonorrhea. The grains are edible and the straw is utilized as fodder.

8. **Pennisetum compressum**

Pennisetum compressum and other species like *P glaucum*, *P. typhoideum* commonly known as 'Bajra' are cultivated throughout the country. These are useful in heart diseases.

9. **Phragmites karka (Retz.) Trin**

This plant is a tall perennial grass distributed throughout the country and is very common in wet places Commonly it is called 'Narkul' and 'Nal' while in English it is known as 'Common Reed Grass'.

The grass is useful in biliousness, urinary troubles, vaginal and uterine complaints, erysipelas and heart diseases The plant is having good place in ayurvedic medicines The culms of grass are also utilized for preparing chairs, baskets and mats, etc.

10. **Saccharum officinarum Linn.**

This tall many noded grass is cultivated throughout the tropical regions of the country for its sweet juice. Commonly it is called 'Ikh' or 'Ganna' and 'Sugarcane' in English.

The stem and roots of the plant enter into ayurvedic prescription as diuretic, cooling and aphrodisiac. It is also recommended for intestinal troubles, anaemia, erysipelas and leprosy. The various parts of the plant have figures in cures for snake-bite The molasses is utilized in cooking, also for preparing rum, industrial alcohol and synthetic rubber, etc.

Saccharum munja Roxb.

This is a very large tufted fodder grass mostly cultivated for its valuable fibre. Commonly it is known as 'munja'.

The stem is refrigerant and is useful in burning sensation, blood troubles and in urinary complaints. The lower part of the stem is consumed in making chairs,

tables, baskets, screens and lining for walls. The upper half of the stem is used for thatching house, boats, carts, etc.

11. Setaria Italica (Linn.) P. Beauv

This grass is found occasionally in marshy places and cultivated in Andhra Pradesh, Tamil Nadu and Assam hills for its grain. In English it is commonly called as 'Italian Millet' while in Hindi it is known as 'Kaugni'.

The grains of the plant are diuretic and astringent and externally recommended in rheumatism

The fruiting heads of *Setaria Verticillata* known as 'Laptuna' in Hindi are an effective protection against rats.

12. Triticum Aestivum Linn.

This plant is widely cultivated throughout the country as 'rabi' crop Commonly it is known as 'Genhu'.

The seeds of the plant enter into many prescriptions of ayurvedic practitioners. It is laxative, a tonic and an aphrodisiac. The grains are cooling, nourishing, fattening and increase appetite and relish for food.

13. Vetiveria zizanioides (Linn.) Nash

Plant is well distributed throughout the country specially near the banks of rivers, canals and ponds. It is commonly called 'Khas Khas' in Hindi and 'Vetiver' in English.

This perennial grass is famous for its sweet-smelling roots. Its roots are ayurvedic cure for snake and scorpion sting. The infusion of the roots brings relief in fever, blood diseases, biliousness, excessive sweating and so on. The paste made of the ground roots applied to bruises, swelling and burning sensation and has an almost magical effect.

14. Zea mays Linn.

A tall annual grass cultivated as food crop in northern sloppy areas of the country. Commonly it is called 'Makka' or 'Bhutta' in Hindi and 'Maize' in English.

The grains are astringent, nutritive, nourishing and are considered to be a suitable diet in consumption and in relaxed condition of bowels. The corn is eaten and the foliaceous bracts in which the inflorescences are concealed are used as a wrapping for cigarettes.

Besides these above grasses other grasses having aromatic oil in their cells have acquired a reputation as cures for various ills and also specific in disorders ranging from constipation to dysentery and cholera.

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Science Nobel Laureates of 1971

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THE 1971 Nobel Prize for Chemistry has been awarded to Dr. Gerhard Herzberg, 67 years old Director of the Division of Pure Physics of Canada's National Research Council in Ottawa, for "his contributions to the knowledge of electronic structure and geometry of molecules particularly free radicals." The 1971 Nobel Prize for Physics has been awarded to Dr Dennis Gabor, 71 years old, who is both professor emeritus at London's Imperial College of Science and Technology and a staff scientist at the Columbia Broadcasting System Laboratories at Stamford, Connecticut, U.S A , for his work in the development of the three-dimensional photography, otherwise known as holography. The 1971 Nobel Prize for Medicine (Physiology) went to Dr Earl Wilbur Sutherland, Jr , 55 years old Professor of Physiology in Nashville's Vanderbilt University School of Medicine for "his discoveries concerning the mechanisms of the action of hormones." The 1971 Nobel Memorial Prize in Economics went to Dr. Simon Kuznets, 70 years old, until recently Professor of Economics at Harvard University, who in the 1930's helped originate the concept of the gross national product, the measurement of the output of goods and services in a nation's economy.

Dr. Herzberg

Dr. Herzberg is renowned for having determined the structures of a large number of diatomic and polyatomic molecules, including structures of many free radicals and for having successfully applied spectroscopic studies to the identification of certain molecules in planetary atmospheres, comets and interstellar space. Spectroscopy involves observations by means of an optical device of wave length and intensity of electromagnetic radiation absorbed or emitted by various materials. Each element has its own characteristic spectrum that can be used as a kind of finger-print. When exposed to an appropriate form of radiation it produces a spectral pattern unique to the element. Spectroscopy provides chemists and physicists precise information on molecular energies, rotations, vibrations electronic structures. Dr. Herzberg used spectroscopy to study the structures of molecules and free radicals. Free radicals and fragments of molecules are highly reactive and combine easily with other molecules. He obtained the spectra of methyl and methylene radicals and thereby deduced information about their structures and showed that these radicals were indeed there is their free state. He also established that one carbon atom and three hydrogen atoms of methyl radicals were arranged in one plane. Born in Hamburg, Germany on December 25, 1904, young Herzberg studied at Darmstadt Institute of Technology, receiving a Ph.D. degree in 1928, and at the University of Bristol, England. He held a faculty position at Darmstadt Institute of Technology (1930-35). He left Germany, went to the University of Saskatchewan in 1935 and remained there until 1945. During 1945-48 he taught at the University of Chicago. He joined Canada's National Research Council in 1948

and is now its Director of Pure Physics since 1955. He authored about 200 publications in spectroscopy and quantum mechanics and monumental three-volume work entitled "Molecular Spectra and Molecular Structure". Recipient of F. Ives Medal of the Optical Society of America (1964), a fellow of London's Royal Society, Dr. Herzberg was president of the Canadian Royal Society (1966-67) and vice-president of the International Union of Pure and Applied Physics (1957-63).

Dr. Gabor

Born in Budapest on June 5, 1900, young Gabor had his higher studies in Budapest (1919-20) and in Berlin, earning his Ph. D. degree in electrical engineering in 1927. After working as a research engineer in a German electrical concern (1927-33) he went to England where he worked for a British company (1933-48) until he joined the Imperial College in 1949 to teach applied electronic physics, becoming its professor in 1958 He is associated with the Columbia Broadcasting System Laboratories at Stamford since 1957 A fellow of London's Royal Society (1956), Dr. Gabor has more than 100 patents of his own; a number of them relate to applications of his work in holography. In holography, a beam of coherent light produced by a laser source is split by a mirror. One part goes directly to an emulsified plate; the other part is directed at the object to be photographed and then reflected on to the plate. When the light waves reflected from the object meet the waves arriving directly from the light source the interaction produces submicroscopic patterns of dark and light areas on the plate. These interference patterns encode in the emulsion all the characteristics of the waves reflected from the object. After the plate has been developed it is again illuminated by a beam of coherent light. This applied light is altered by the interference patterns on the plate so that the light reaches the eye with all the characteristics of the light reflected from the object. Thus a three-dimensional image is obtained. It is hoped that in future, holography, the three-dimensional photography without the use of a lens, may be used in testing materials, in medical examinations and in the more efficient storage of information in computers. Holography may be used to make three-dimensional movies and television pictures that viewers may watch without wearing specialized spectacles.

Dr. Sutherland

Dr. Sutherland unravelled the secrets of how hormones work through an intermediary substance known as cyclic adenosine 3,5-mono-phosphate (AMP) Cyclic AMP is now said to be the master molecule involved in the control and regulation of metabolic activities of individual cells. Changes in the level of cyclic AMP within cells either increase or decrease the rate at which cells carry out their appropriate functions—many of the cellular functions once thought to be controlled by cyclic AMP acting as an intermediary. Born at Burlingame, Kansas, on November 19, 1915, young Sutherland received his medical degree form St. Louis' Washington University in 1942. He started his career as an assistant pharmacologist at the same University (1942-45) with Dr. Carl Cori, the 1947 Medicine Nobelist and worked on how adrenaline regulates the degradation of glycogen glucose in the liver. Later, he became an instructor there (1945-50), an assistant professor (1950-52), an associate professor (1952-53). Next he moved to Cleveland's Western Reserve University School of Medicine as a professor (1953-63) Since 1963 he is the professor of Physiology in the School of Medicine of Vanderbilt University

at Nashville. A member of the U.S. National Academy of Science, Dr. Sutherland received the 1970 Albert Lasker Award for Basic Medical Research

Dr. Kuznets

Born in 1901 in Kharkov, Russia, young Kuznets came to the U.S.A. in 1922, entered Columbia University and got his Ph. D. degree in 1926. For about a year he served as a fellow of Social Science Research Council and in 1927 joined the staff of the National Bureau of Economics where he began his studies of business cycles and economic growth.

During 1930-54, Dr. Kuznets taught at the University of Pennsylvania, and during 1954-60 at the Johns Hopkins University. In 1960 he joined Harvard University and retired in the middle of 1971. For the last 40 years he has been studying the economic growth of developed and underdeveloped countries, developing methods that are now being used by many countries to determine the gross national product (G.N.P.) which is the sum of a nation's goods and services. Dr. Kuznets is regarded as the Father of G.N.P.

Ticks and Our Livestock

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AMONG joint-footed invertebrates (Arthropods) the ticks form a group or class *Arachnida*. The adults are eight-legged creatures, one sixteenth to nearly one-quarter of an inch when unfed. All ticks have only six legs in the larval stage and hence resemble insects. They cannot run, jump or fly but are dependent on blood for their existence. They are distinguished from spiders by having fused body, from the mites by the mouth parts, which are grouped to form moveable *capitulum*. Other features which distinguish ticks from true insects are : the absence of three clear-cut divisions of the body, viz., head, thorax and abdomen found in the case of adult true insects, and the absence of the organs known as antennae or feelers.

All ticks are parasitic on vertebrate animals. Both the sexes live on blood and lymph of the host. The ticks are divisible into two main groups, viz., the hard ticks (Ixodid ticks) and the soft ticks (Argasid ticks). The former are characterised by the presence of hard shield (scutum) on the upper surface of the body. In male the entire body is covered by the shield while in female only part of the fore end is covered by it. The so-called soft ticks do not possess a scutum.

In all, there are four distinct stages in the life-cycle of a tick. These are the egg, the larva (or the seed tick), the nymph and the adult. The eggs are deposited on the skin of the host, in pastures and animal sheds or other surroundings. The single female lays as many as fifteen thousand eggs and dies. After a few days, the six-legged larva (seed tick) comes out of the egg. They attach to the host and feed on its blood and lymph. When fully engorged, it moults and turns into the *nymphal stage* with four pairs of legs. The nymph resembles the adult, except in its smaller size and absence of genital pore. When the nymph moults after engorgement, the tick reaches the adult stage.

In case of soft ticks, there are more than one nymphal stages in the life-cycle. The male is smaller in size than the female. It spends life wandering about in search of unfertilized female. The female soft tick when fully fed drops off the body of the host and lays eggs on the ground. In hard ticks, the female lays all the eggs in one batch and then dies. In soft ticks, female lays eggs in several batches in its life time.

There are three types of ticks in relation to host.

One Host Tick

Some ticks attach themselves to the host as larvae, and remain there till the adult stage. After being fully engorged the females drop off the body of the host in order to lay eggs on the ground. Such ticks are called *one host ticks*, e.g. *Boophilus microplus.*

Two Host Tick

In this case the larva attaches to the body of the host, engorges and moults to the nymphal stage, without dropping from the body of the host. The nymph, however, after engorgement drops off and moults to the adult stage on the ground. This fully ground tick again attaches itself to another host for feed-

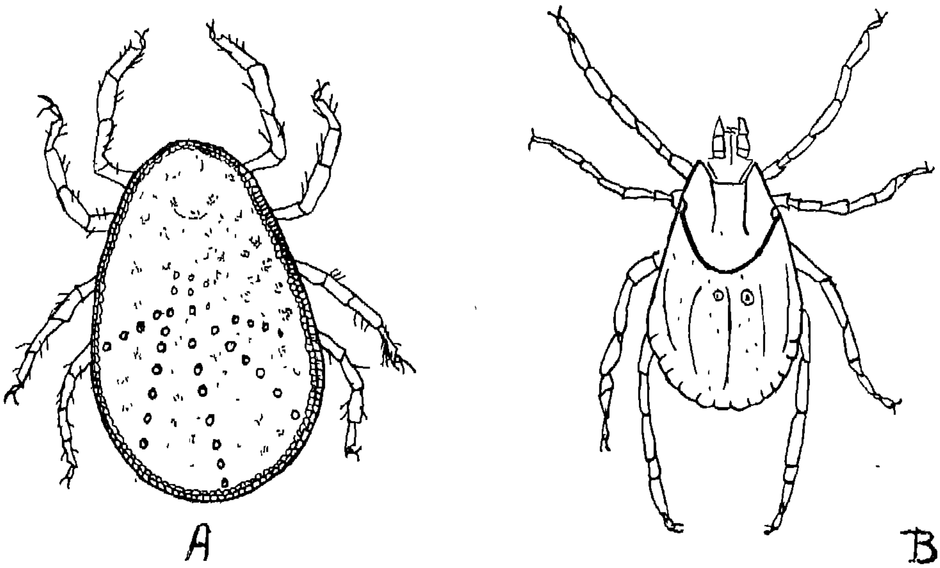

Fig. 1 A. *Soft Tick*—Argas persicus (*Fowl Tick*) (*Dorsal View*).
B. *Hard Tick*—Dermacentor variabilis (*after Snodgross*) (*Dorsal View*).

ing. These may be called *two host ticks*, e.g. *Hyalomma excavatum.*

Three Host Tick

In such type of ticks each of the three active stages, viz. the larva, the nymph and the adult, attaches itself to different hosts to feed. And when engorged the larva and the nymph drop off the host body to move to the next respective stage. Such ticks are called *three host ticks* e.g., *Haemaphysalis bispinosa.*

These three kinds of life-cycles are found amongst the hard ticks or Ixodid ticks. In the case of soft ticks (Argasid ticks) the larval stage alone remains attached to the body of the host for any length of time in order to feed itself. Nymphs and adult remain hiding away in sheltered places of the host's habitat and come out to feed on the host only for a short time mostly during the night.

In India the important species of ticks highly harmful to the livestock and poultry are:

Hyalomma excavatum,
Boophilus microplus (cattle tick)
Rhipicephalus sanguineus (dog tick)
Rhipicephalus haemaphysaloides,
Haemaphysalis bispinosa,
Argas persicus (fowl tick)

The ticks are reservoir hosts for a variety of pathogens, causing fatal diseases in poultry and cattle. A great variety of hosts is attacked by ticks. Fish are the only major vertebrate group that escape their attention. It would not be astonishing if some obscure tick with vertebrate host habits were discovered, perhaps only in regard to requirement for vertebrate blood. Tick parasitism of *sea-snakes, amphibia, seals, water birds* and other inhabitants of aquatic environments

is well known. An important example is ubiquitous brown dog-tick (Rhipicephalus sanguineus), whose habits of attacking and transmitting disease causing micro-organisms to man in certain parts of the old world, Kashmir and lacking in other areas of abundance.

The tick-borne diseases are of several categories.

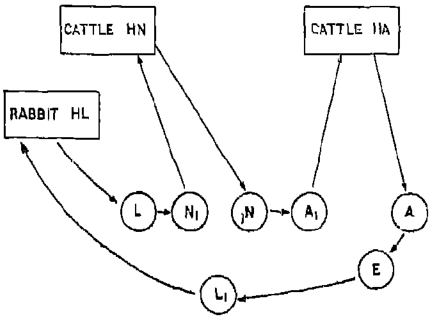

Fig. 2. *Life cycle of the two host cattle tick* Hyalomma excavatum.

A, engorged adult female laying eggs; A_1, unfed adult female; E, egg mass; HA, host of adults; HL, larval host, HN, nymphal host; L, engorged larva; L_1, unfed larva; N, engorged nymph; N_1, unfed nymph.

I. Tick-borne Viral Diseases

Disease in squirrels, chipmunks, etc. Another virus disease is the "Silver Water virus".

II. Bacterial Diseases

The tick-borne bacterial diseases include Tularemia Brucellosi, Anaplasmosis, Leptospirosis, Spirochaetosis. The diseases caused great trouble to our cattle and poultry all over the world.

III. Protozoan Diseases

The most important disease caused by ticks due to protozoans is *Theilerosis*. Tick-borne protozoan parasites are, Theileria, Gondaria and Cytauxzoon. All of these cause important diseases of animals excluding man chiefly in the eastern hemisphere of which East Coast Fever (ECF) of cattle is probably the best known. A new disease of cattle in Zululand is termed "Corridor Disease" related but not identical to ECF.

Other multicellular parasites which are tick-borne include the filarial worm Dipetalonema wirei etc. (transmitted by soft ticks).

Tick Paralysis

A good deal of literature is available on the tick paralysis and tick toxicosis. There are many records of serious effects from the tick bites. Massive infestation of animals can result in general weakness and even death due to loss of blood. A toxic substance in tick eggs '(ixo=voto=xim)' has long been known by riek in Australia.

Tick Paralysis is caused by a neurotoxin affecting man and animals in several parts of the world. This subject of tick paralysis has received much attention all over the world.

The studies on ticks are of prime importance with regard to the health of livestock and poultry of the country.

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Environmental Protection versus Pest Control*

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PUBLIC concern and interest in environmental problems has recently become very popular. This is a good healthy condition because our environment encompasses all of the elements which sustain our lives In addition, the "outdoor" environment also furnishes us with most of our recreation, solitude, peace of mind, and settings for contemplation. Therefore, it is very important that we have some experienced people who watch the plants and animals for signs of reaction to any change in our environment. Sometimes it is possible to ascertain dangerous and critical conditions at an early stage because the plants and wild animals often react quickly to some of these changes. Surely, all rational people have a strong concern and respect for environmental relationships.

But regretably, a great many of the vociferous and newly concerned do not have a very comprehensive knowledge or appreciation of the complexities of most of our environmental relationships. This results in voluminous speeches and stacks of written articles which expound on some specific problem, and then follow up with listings of erroneous causes, misinterpretations, oversimplified corrections, and frequently crackpot remedies.

It is also a sad commentary when so many of these emotional outbursts come from individuals who are classed as "academic experts". Too often these experts are guilty of being in the forest so deep that they can no longer see the trees, or of having specialized so long and so intensively they can no longer see over the side of their own private "rut". But they do often stir up a hornet's nest of public opinion because the general public has every right to assume they know what they are talking about.

One of the most misunderstood and improperly supported of the "slogan remedies" is the concept of "balance of nature" or as has been recently popularized, "biological control." Very surely there are some specific locations and conditions where man has manipulated biological principles to effect some specific results. But remember, man is doing this—not nature. By and large, there has never been such a thing as a balance of nature, otherwise we would likely still be living a world dominated by reptiles.

By knowing the physiology and life-cycle of some damaging species, man has been able to regulate critical biological relationships to drastically reduce population levels of the damaging species. It is hoped that efforts will be continued toward finding similar checks for other species, but the controlling conditions are very specific and they cannot be expected to work on just any insect or animal.

When biological manipulation is considered as a "major" substitute for pest control, then some additional factors should be considered. For example, would a tremendously increased number of a predatory species be more desirable than the use of a short-lived specific chemical? Even the use of heat and light for some con-

'e agriculture radically changes the numbers and kinds of insects and animals s rats) which will be able to live in an area.

might have a more drastic effect on l ecology than the regulated use of ontrol methods.

ime example of miscalculated biolo- anipulation involved India a few years ome enterprising people decided the n mongoose from this country would effective control for the rats in Hawaii ie Virgin Islands. So the mongoose ransported to these areas—and what he result? The mongoose ate a few but it also ate many of the chickens nearly wiped out the ground nesting ds. At the present time the mongoose s perhaps a worse pest in Hawaii than the rats, and the Virgin Islands are having a terrible time trying to keep away the mongoose from completely destroying the native parrots which are on the list of "endangered" birds.

The same kind of relationship developed in the United States where the European starling was imported to eat insects, but is now costing millions of dollars in damage without accomplishing the insect control. There are many other examples of miscalculated biological manipulation, including the disaster of transplanting rabbit virus from England to Australia

When pest control or pest management becomes desirable, it also usually involves a question of mind, and manipulation may not produce results rapidly enough to serve the needs. Nature moves inexorably onward—but she moves rather slow in most cases. And in spite of the fact that pest control usually implies someone's financial investment, it may also involve the food supplies we require, the clothes we wear, the houses we live in, and the state of our health. In many such situations, time can be the critical element,

The capacity of "non-farm" lands to support rodents and insects is often changed by the concentration of domestic livestock.

Even when time is not that critical, where do you draw the line on the use of chemicals to produce the food for hungry people mining and smelting which pollutes the air but gives us the metals for electric appliances and for industry—automobiles and hard surfaced roads which help to foul the air and distribute virus but give us a capability for quick reaction to disaster and distribution of food reservoirs and wells which provide irrigation for miles and miles of crops, but also attract and foster the insects that become pests the first place? For that matter, the control of most disease organisms is also a form of pest control.

The basic concerns of pest control should not be tied to whether or not chemicals are to be used, but rather to the types of controls required and the best regulated methods to produce the desired results. There should always be careful consideration of the need for the control as well as careful consideration of the possible and probable side effects on the rest of the ecology.

As long as mankind works at creating a better standard of living for himself by planting crops, storing foods, irrigating lands, raising livestocks, building houses, and even in controlling diseases—then some degree of pest control is going to be required. Therefore, I would suggest that the discussions "for and against" pest control should include the following points (as well as others which relate to specific conditions):

1. What are the conditions which have caused and maintain the need for the control?
2. What are the known methods for correcting the problem?
3. What are the known hazards and side effects of the candidate control methods?
4. What are the long and short term values to be expected, both good and bad?

With these simple determinations it can often be possible to evaluate the balance between "cost and benefit". These steps presume that research towards better control methods and more understanding will continue, and that intelligent regulations and restrictions against careless and hazardous control applications will continue.

Who knows, with proper management and research even poor maligned D.D may again become the saviour of mank

Even grassy parks and maidans change the population dynamics of insects and animals, thereby causing some pest control problems.

Or should we have solved some of our present day population problems by letting additional millions of people perish from malaria and typhus a few years back?

*Reproduced from *Participant Journal*. October, 1971.

Classroom experiments

Molecular Theory of Magnetism : A Classroom Demonstration

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Introduction

WEBER was the first to propound the molecular theory of magnetism. According to him, all magnetic materials are made of molecular magnets. In the unmagnetised condition, these molecular magnets are distributed with random orientations (Fig. 1) and the resultant effect is the absence of magnetic behaviour.

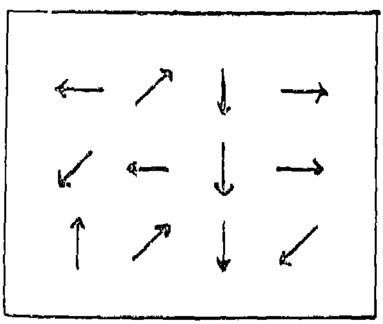

Fig. 1

When such a material is placed in a magnetic field (produced either by a permanent magnet or a coil carrying current), the molecular magnets swing in the direction of the field (Fig. 2). Thus, this leads to free polarities at the two ends of the substance.

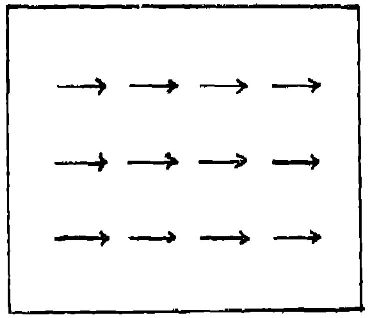

Fig. 2.

On reversing the direction of the magnetic field (say by reversing the direction of D.C. current), the molecular magnets will now orient themselves in a direction opposite to that shown in Fig. 2 and the polarities will be reversed (Fig. 3).

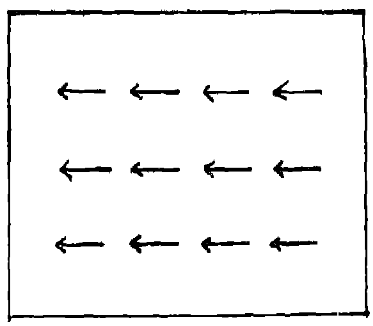

Fig. 3

The present paper describes a very simple two-dimensional teaching aid which can be used for explaining the basic principles of the molecular theory of magnetism.

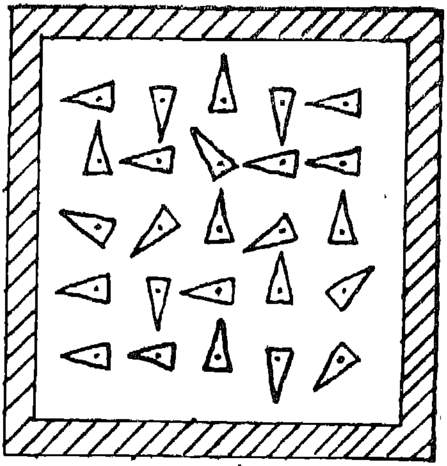

Fig 4

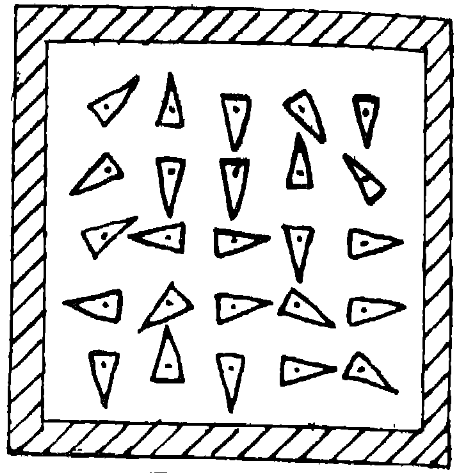

Fig. 5A

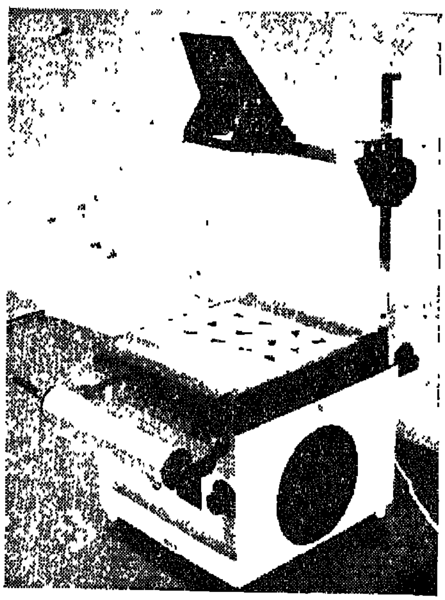

Fig. 4 a.

Photograph showing the teaching aid mounted on the Overhead Projector.

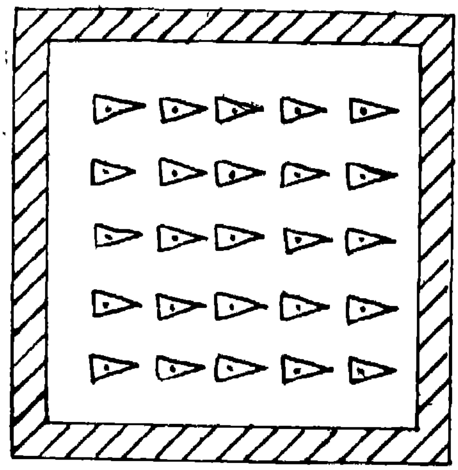

Fig 5B

The Teaching Aid

The teaching aid is to be used in conjunction with an overhead projector. The aid is as shown in Fig. 4 and the photograph (Fig. 4a).

It consists of a cardboard (or plywood)

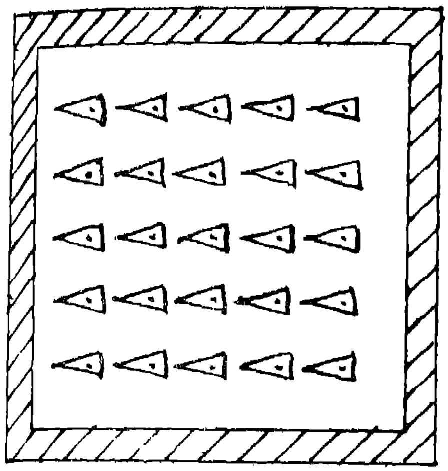

Fig 5C

frame 25 cm square and 3 cm width. On to this frame is fixed a sheet of transparent acetate paper so that it covers the whole frame. Cardboard (or plywood) triangles (isosceles, base 1 cm and height 3 cm) are fixed by means of drawing pins on the acetate paper, so that they are able to rotate about the pins in a horizontal plane.

The pins are fixed with their pointed ends projecting above the acetate sheet when the latter is placed on the overhead projector. This is done in order that the pins do not scratch the top glass plate of the overhead projector. The pins may be kept in position by pasting small pieces of cellotape on the pin-heads. The fixing can, however, be made permanent by using rivets to fix the triangles on to the acetate sheet.

The triangles represent molecular magnets with their apexes as the north pole, while the frame with the acetate paper represent the magnetic substance.

Demonstration

The aid (as a whole) represents a magnified view of the substance with its molecular magnets.

The demonstration is best carried out in the following steps:

Sl. No.	*Operation*	*Observation*	*Inference*
1.	Orient the triangles at random so that no two triangles point in one particular direction.	Random orientation of the molecular magnets	Unmagnetised body (Fig. 5A)
2.	Orient all the triangles such that all the vertices are unidirectional.	Uni-directional orientation of the molecular magnets.	Magnetised body (Fig 5B)
3.	Reverse the orientation of the vertices of the triangles in a direction opposite to that in Serial No. 2.	Uni-directional orientation of the molecular magnets (in opp. direction).	Body magnetised in the reverse direction (Fig. 5C)

Further Applications

This teaching device can be used for explaining yet another interesting physical phenomenon, viz. the process of induction heating by alternating currents.

An alternating current (A.C.) is one in which the voltage varies (as a function of time) between negative and positive values. Now, if a magnetic substance be subjected to an A.C., the polarities will reverse as many times as the frequency of the A.C. supply. The friction, thereby generated, gives rise to heat and hence the warming up of the materials.

The above concept can be very beautifully driven home through this aid. By considering one of the triangles (i.e , molecular magnet), the same will be made to change its direction assuming the field direction to be reversed. Thus, assuming that the field is being generated by an A.C., the arrow will reverse direction as many times as the supply frequency. This will show as to why friction should arise and as to why heat should be generated.

Acknowledgements

The author wishes to thank Mr. K. A. Reynolds, University of Aston in Birmingham (U.K.) and erstwhile UNESCO Expert in National Institute of Foundry and Forge Technology, Ranchi, for the unstinting help rendered by him. The Director, NIFFT is also to be thanked for providing the necessary facilities.

Measuring Rates of Respiration

PRECISE measurements of the rate of respiration require elaborate equipment. We can, however, obtain reasonably accurate measurements using simpler methods. This is often done by placing the living material in a closed system and measuring the amount of oxygen that comes out. By using suitable techniques, we can measure the amounts of one or both of these gases over a given period of time and determine the respiration rate. A simple volumeter can be set up as illustrated in Fig. 1.

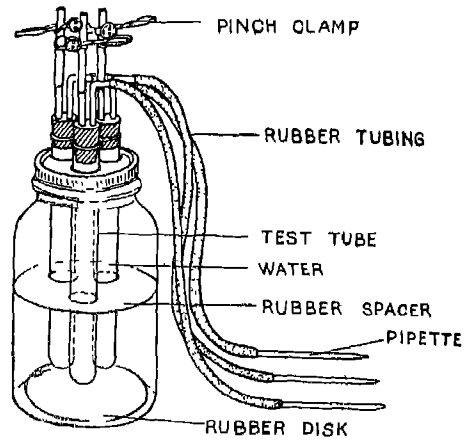

Fig. 1. *Volumeter*

The volumeter should be arranged as follows. The material for which respiration measurements are desired is placed in one or more test tubes of uniform size. Each tube contains a stopper and pipette as shown in the illustration. One of the test tubes contains an inert material such as glass beads or washed gravel and is used to correct changes in temperature and pressure which cannot be completely controlled in the system. This tube is called a thermobarometer. Equal volumes of both test and inert materials must be placed in all the tubes This precaution is necessary to assure that an equal volume of air is present in each tube. A very small drop of coloured liquid is inserted into each

pipette at its outer end. This closes the tube so that if there is any change in the volume of gas left in the tube, the drops of coloured liquid will move. (The direction of movement depends on whether the volume of gas in the system increases or decreases). The distance of movement over a given period of time can be read from a ruler placed on the side of the pipette. The volume of gas added or removed from the system can be read directly from the calibrated pipette.

In attempting to measure respiration with the equipment just described, we must take into consideration not only that oxygen which goes into the living material (and thus out of our volumeter test tube), but also that carbon dioxide that comes out of the living material (and thus enters into the volumeter test tube). If we are to measure the oxygen uptake in our respiring material, we must first strap the carbon dioxide as it evolves. This can be done by adding any substance (ascarite is commonly used) which will absorb the carbon dioxide as fast as it is evolved. Efficient removal prevents the carbon dioxide from being added to the volume of gas in the tube.

Each team should set up one volumeter and compare the respiration of dry seeds with those which have been soaked for 24 hours. The work involved in setting up the volumeter and in obtaining measurements is difficult to complete in one laboratory period. It is very important that certain preparations be made in advance and that each member of the team understands clearly what is to be done.

Materials (Per Team)

1. One volumeter (complete)
2. One thermometer
3. One hundred Alaska pea seeds
4. Germination tray
5. 100-ml graduated cylinder
6. Glass beads
7. Three beakers, 150 ml
8. Solution dye
9. Cotton
10. Ascarite
11. Eyedropper

Procedure Day I

Each team should place 40 pea seeds in a germination tray between layers of wet paper towels and allow them to soak for 24 hours. (Label the trays as to team, class, experiment and date).

Procedure Day II

1. Determine the volume of the 40 soaked seeds. This volume will be used as a standard for preparing materials for the other two test tubes in the volumeter. (Volumes of solid subjects, including seeds, can be determined readily by adding them to a measured volume of water in a graduated cylinder and reading the volume of displaced water).
2. Determine how many glass beads must be put in the tube with the dry seeds so that the volume of air in the tubes with soaked and with dry seeds will be the same. To do this, place 25 ml of water in a 100 ml graduated cylinder. Add the dry seeds. Then add enough beads so that the increase of the water level in the cylinder containing both seeds and beads is equal to the volume of the seeds soaked for 24 hours. Dry the 40 seeds and the glass beads by blotting them with paper toweling or cleansing tissue. Place the dried

seeds and beads together in a beaker. Label the beaker and store it in the laboratory until you are ready to use the volumeter the following day.

3. Obtain the same volume of glass beads as that determined for the soaked pea seeds. Place these in a beaker, label the beaker, and store it in the laboratory until you are ready to set up the volumeter on the third day.
4. Mix about 25 ml of a dilute solution of vegetable dye (food colouring) in water and add a drop of detergent.
5. Set up the volumeter as illustrated in Fig. 1. Add water to the jar in which the test tubes are immersed, but do not add anything to the test tubes.

Procedure Day III

1. Remove the stopper from each of the three test tubes. Add the 40 soaked pea seeds to one tube ; add the dry pea seeds and glass beads which you measured out in Step 2 to the second tube ; and add the glass beads measured out in Step 3 to the third tube. Loosely pack cotton over the material in each tube to a depth of $\frac{1}{2}$ inch. Add $\frac{1}{4}$ teaspoon of ascarite or sodium hydroxide to the top of the cotton in each tube.

   CAUTION: Ascarite is caustic. Be very careful not to get it on your hands, your body, or on your clothes. If some is spilled, clean it up with a dry paper towel or paper cleansing tissue. Do not use damp cloth or paper as ascarite reacts strongly with water. The tube should now be packed as illustrated in the illustration below

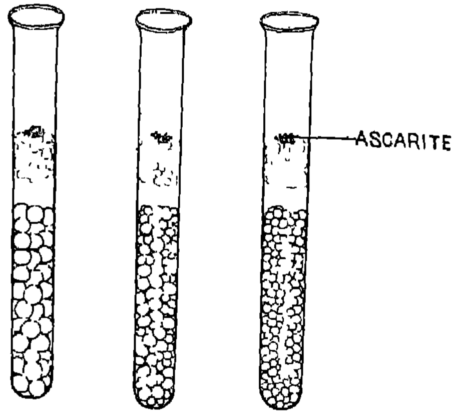

Fig. 2. *Volumeter tubes after preparation.*

2. Replace the stoppers and arrange the pipettes so that they are level on the table.
3. With a dropper, add a small drop of coloured water to each of the three pipettes. (See Step 4 of Procedure, Day II.)

   The diagram shows set up of stopper and pipettes attached to each tube in volumeter. After coloured water indicator has been introduced at outer end of pipette, it can be adjusted by opening pinch clamp and drawing air from system or pushing it into system with eye dropper inserted into rubber tube at top of apparatus.

   Adjust the marker drops so that the drop in the pipette and the other drops are placed near the outer ends of the pipettes.
4. Allow the apparatus to sit for about 5 minutes before making measurements.

5. For 20 minutes, at 2-minute intervals, record the distance the drop moves from its starting point. (If respiration is rapid it may be necessary to readjust the drop with the medicine dropper as described in Step 3. If readjustment is necessary, add the new readings to the old readings so that the total change during the time of the experiment will be recorded). Record your results as illustrated below.

GAS VOLUME CHANGES IN A CLOSED SYSTEM CONTAINING GERMINATING PEAS AND DRY PEAS

Time	*Thermo-barometer readings (ml)*	*Readings for germinating peas (ml)*	*Readings for dry peas (ml)*

Note: If the drop in the thermo-barometer pipette moves toward the test tube, subtract the distance it moves from the distance the drop moves in each of the other pipettes. If the drop in the thermometer pipette moves away from the test tube, add the distance it moves to the distance the drop moves in each of the other pipettes.

By courtesy: Science Teaching Centre, University of Maryland, U.S.A.

Science Abroad

*Curiosity Leads Physician to 1971 Nobel Prize**

WALTER FROEHLICH

CURIOSITY—an impelling desire to know and understand—about the workings of certain aspects of the human body drove an American physician into research work that won him the 1971 Nobel Prize in Physiology and Medicine.

There was no specific intent to discover ways to cure or prevent any particular disease, or find a new method for improving health, on the part of Dr. Earl W. Sutherland (Junior) when he began his explorations 25 years ago into body chemicals called hormones.

Dr. Sutherland was successful. He achieved what he set out to do, and that was acknowledged by the Karolinska Medical Institute in Stockholm, Sweden, which administers the annual Nobel awards.

"The mechanism by which various hormones exert their important functions has until recently been a complete enigma", said the institute in its announcement of the selection of Dr. Sutherland for the prize. "Because of the work of Dr. Sutherland, we can today understand the general mode of action of many of them."

The implications of that understanding cannot yet be foreseen, except that in the history of science and medicine such new understandings of nature have almost invariably led to benefits.

Dr. Sutherland himself predicted that in what will probably turn out to be an understatement : "It seems not unrealistic to hope that somewhere along the line, as a happy by-product of this research, a new or improved method of therapy will become available."

Hormones are chemical substances formed in various organs or glands of the body. They are secreted into the blood stream or into other body fluids which carry them to other body parts which they stimulate to increased activity or generate some other effect. Thus, in essence, hormones are messengers through which body parts coordinate their actions.

Dr. Sutherland began his hormone investigations partly as a hobby in the late 1940's while holding a job as a research worker at Washington University in St. Louis, Missouri He noted what other researchers had overlooked that another substance cyclic AMP, rather than hormones, often acted as messengers that motivated cells to alter the rate at which they carried out their tasks.

He found that hormones produced cyclic AMP as needed, though in other cases the sequence was almost reversed in that cyclic AMP triggered hormones into action. The letters AMP stand for adenosine monophosphate Because the atoms in its molecules are arranged in a ring, the term cyclic is used.

When Dr. Sutherland revealed his findings in 1956, his colleagues in the medical

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*Reproduced from *Participant Journal*, October, 1971.

community were sceptical and he was criticized. In the following ten years, he conducted a series of experiments which have since been described as 'brilliantly designed and carefully controlled' to decisively prove the profound influences of cyclic AMP on the body. He showed that cyclic AMP is contained in exceedingly small quantities in every living cell, influencing that cell throughout its life.

"There are just traces of it in you," said Dr. Sutherland while explaining his discovery, "but it is what controls your cells—everything from your memory to your toes"

Quickly, the discovery of cyclic AMP became recognized as a major advance in the study of life Interest mushroomed to such an extent that today an estimated 2,000 scientists are conducting research on cyclic AMP. The promise it holds for leading to new medicines and other disease controls is so great that almost every major pharmaceutical laboratory in the world is believed to have a team assigned to cyclic AMP research.

Some drugs now in use are believed to alter the levels of cyclic AMP, and new drugs may eventually be designed to add or suppress cyclic AMP in the treatment of diabetes, cholera, or even cancer, and a host of other diseases.

Dr. Sutherland, who will be 57 years old on November 19, 1972, is a professor of Physiology at Vanderbilt University in Nashville, Tennessee. He has won numerous other awards for his research.

Though Dr. Sutherland's work was concentrated on only a small segment of biology, the avenues and approaches of his discoveries that have opened are so all-encompassing that their ultimate effect is bound to reach into almost every phase of study of health and disease.

*Anything but Chicken Feed : How Christiaan Eijkman—Nobel Prize Winner in 1929—Discovered Vitamin**

A disease which broke out in July, 1887 among hens kept by a medical laboratory on the outskirts of the Indonesian capital of Jakatra, led to one of the most beneficial discoveries of modern times, viz. the discovery of vitamins. With their pioneering work in the field of these remarkable "life-substances", the Dutch scientist, Christiaan Eijkman, made an immortal contribution to the welfare of mankind. In 1929 their efforts were crowned with the joint award of the highest distinction which could be bestowed upon them—the Noble Prize for Medicine.

Long before this, however, Christiaan Eijkman had laid the foundations for modern dietetics. He conquered one of the most malignant of tropical diseases and saved thousands of human lives by laying open the 'secret of the grain of rice.'

We all need a little luck if we are to prosper; the scientist is no exception to this rule. Many of the great discoveries in the world would perhaps never—or at best only much later—have been made were it not for the helping hand of Fortune. This was certainly the case in the discovery of vitamin, a discovery which may be counted among the most important in the history of medical science. If those hens had not fallen sick in Jakarta on July 10th, 1887, Eijkman might never have reached his startling discovery that the notorious tropical disease known as Beri

*Reproduced from *The Netherlands*, June 1971.

Beri was caused by the absence of a certain vitamin in the diet. This discovery formed the basis upon which the whole modern vitamin and dietetic sciences are built.

Nowadays every housewife knows that vitamins are among the most important components of our diet. Without them babies would not grow into strong and healthy youngsters. And if an adult person were to subsist for any length of time on a vitaminless diet, serious illness and eventually, death would be his lot. At the beginning of the present century the knowledge of vitamin was sparse; the word became popular only in 1912 at the initiative of a scientist named Casimir Funk, whose aim was to show how important vitamins were to life (Lat. vita).

In the years preceding the First World War, only four vitamins were known (A, B, C, and D); today there are scores and these are partly divided into groups such as the B-group which consists of nine vitamins and which is found in yeast. This does not mean that the subject is complete; on the contrary, it is only a few years since vitamin B12 was discovered and only since the end of the Second World War has the manufacture of vitamin preparations got into its stride. Today you can make your choice from a vast range of these preparations in tablet, pill, liquid or ointment form. In addition to these, many foodstuffs which have to be stored for considerable periods are artificially provided with extra vitamin. What exactly are these mysterious 'vitamins'? Generally speaking, we can describe them as chemical substances, some of which are produced in vegetables and some in the bodies of human beings and animals. Many vitamins are found naturally in articles of food such as butter, milk, egg, various fruits, vegetables, cereals, meat and fish.

Others—such as vitamin D—are formed in our bodies from components of our diet.

Although vitamins are of paramount importance to health, the amount needed is very small. A few thousandths of a gramme daily is adequate. Medical men say that a healthy adult, under normal circumstances, absorbs sufficient vitamins provided that his daily meals contain variety. Here, of course, the task of the housewife assumes a very important role.

And having said that, we are at the heart of the matter but the food situation in many areas of the world is still far from ideal. Millions of human being go hungry. Frequently the composition of a diet is one-sided, with the result that many inhabitants of this planet absorb too few vitamins and fall victim to "deficiency diseases." In past centuries, these diseases played havoc with the crews of ships, many of whom were forced to live on pickled meat and ships biscuits for months and who seldom saw milk and its derivatives. Fruits or fresh vegetables, with the result that they absorbed little or no vitamin C. This deficiency soon led to outbreaks of scurvy, which manifested itself in flagging energy, anaemia and painful blisters in the mouth.

In the second half of the 19th century, similar symptoms were observed among the inhabitants of islands in the Indonesian archipelago and elsewhere in South East Asia. In those regions, thousands died every year from the notorious Beri Beri which owes its origin to the Sinhalese term for "I cannot manage it"—a very apt description of the situation in which victims of this catastrophic disease found symptoms of degeneration in the muscular power and paralysis. Moreover in such cases, large quantities

of fluid accumulate in the tissues and, since the heart and respiratory system are also affected, the patient dies in a state of acute congestion. Should the weakened Beri Beri patient also fall victim to other tropical diseases such as malaria or dysentery, his suffering becomes so intense that death is a happy release.

The Dutch authorities in Indonesia in those days were deeply worried by the Beri Beri scourge and in 1886 a committee of experts was sent out with instructions to uncover the mystery of the disease. Among its members was a 28 year old Dutch specialist in tropical sicknesses named Christiaan Eijkman, an extremely retiring young man but possessed with a razorsharp and critical mind and more than average will power, determination and idealism.

Earlier sojourns in tropical regions had served to acquaint Eijkman with the disease and he remembered bitterly the sufferings of those affected by it. Eijkman decided to devote his entire energies to find the cause of Beri Beri. He had observed that the disease usually struck in areas where people lived close together in large numbers; for example on plantations, collective farming settlements, barracks, prisons and even hospitals.

Clearly Eijkman and his colleagues assumed that the disease was a contagious one caused by bacteria. During a lengthy period of sick leave in Europe, recovering from malaria contracted during his service as an army M.O. at Tjilatjap, and which had severely weakened him, Eijkman worked for some time in Berlin under the great Nobel Prize winner Robert Koch, who in 1882 had discovered the tuberculosis bacillus. In those days the world was full of the work of Koch and Pasteur and thus it was understandable that the scientists approached the Beri Beri problem from the bacteriological angle.

It speaks for the ingenuity and independent thinking of Eijkman that he detached himself from his theory and went on to show that Beri Beri was in no way an infectious disease but stemmed from an inadequate diet. Nowadays we know that it is a typical "deficiency sickness" caused by lack of vitamin B1, but in Eijkman's days this was so revolutionary a supposition that it initially met with disbelief. How did Christiaan Eijkman arrive at his pioneering idea? Here luck or if you prefer fortune came to his aid in the shape of the stubborn Administrator of the military hospital in Jakarta. The man probably never realised that his adherence to regulations could lead to such a beneficial conclusion.

As a member of the civilian Beri Beri investigating committee, Eijkman's work came under the control of the civil administration. His one-man laboratory consisting of two modest rooms was, however, in the military hospital building.

Among the scientist's stock-in-trade were several heads of poultry used for experimental purposes, and between June 10th and November 20th of the year 1887, Eijkman gratefully accepted an offer of scraps from the mess table as food for his chickens; these scraps amounted to the remains of boiled rice. A month after commencing with this diet, the hens developed strange sickness, which Eijkman termed polyneuritis gallinarum As the days passed, the birds became thinner staggered with outspread legs across the run, became weaker and weaker until they fell over and could not get up again and finally they

died. The disease intrigued Eijkman; there was a clear connection between the symptoms which the hens had displayed and the symptoms of human Beri Beri victims. In November 1887, suddenly, came salvation. The regulation-minded Administrator discovered somewhere in his book that "civilian" poultry were not entitled to military rations, nor even waste rice from the kitchens; he withdrew permission whereupon Eijkman was forced to buy "gaba"—cheap unhusked rice—from the market for his feathered assistants. Hardly had the birds commenced to eat this a remarkable change took place in their condition, and before long the surviving birds were restored to full health. The disease, then, might have been caused by eating boiled rice; or perhaps, polluted water have been used for boiling. Or the rice perhaps was contaminated by a poisonous substance?

Eijkman soon discovered that the answer did not lie in any of these possibilities. Then he stumbled across the truth, the cause of the sickness among his chickens and of Beri Beri. The removal of the husk deprived the rice of an ingredient which was necessary to health. Suddenly it all became clear to him. Soldiers, prisoners, plantation workers and hospital patients were all fed on rice supplied from government sources which was put through machines to remove the husk.

During that operation the so-called "silver pellicle"—the thin membrane which enclosed the white rice kernel—was lost. Could the solution to the whole mystery lie in that insignificant object? Further research showed Eijkman that there, indeed, lay the clue to the whole thing; the "silver pellicle" contained chemical substances of immense significance to health. Extract of rice bran proved capable of curing not only the sickness among the poultry but also Beri Beri victims.

With this, Christiaan Eijkman had not only made a discovery of unforeseeable proportions but also laid the foundations for the science which we know as dietetics. In the early stages he encountered the greatest difficulty in convincing medical and official circles that the matter was as simple as all that, and that the answer lay in discontinuing the use of machines for de-husking, cleaning and polishing the rice in favour of simple de-husking such as was carried out by the farmers.

Only in 1928 did Eijkman's compatriots Jansen and Donath succeed in obtaining from 300 grammes of rice bran one-tenth of a gramme of crystalline powder whose chemical composition could be established. This was the first pure vitamin B ever to be produced.

The revolutionary new science of dietetics, which was laid down by Eijkman and his assistant Grijns, had meanwhile been generally accepted after a trial period of disbelief. And although Sir Frederick Gowland Hopkins' discovery of "growth vitamins" was certainly as important as that of Christiaan Eijkman, the latter—with his discovery of "anti neuritie" vitamins and his pioneering work on the relationship between diet and health—must be regarded as the man who opened the eyes of humanity to completely new medical insight. His work saved the lives of hundreds of thousands, and in 1917 the Beri Beri hospital near Jakarta was closed for lack of patients.

Christiaan Eijkman, who with his diligent efforts in the field of science brought the Netherlands its sixth Nobel

Prize within a period of thirty years, was one of the, fortunately, many Europeans whose journeys to tropical countries were directed not at accumulating riches but in the service of mankind and for the alleviation of suffering. A year after he, in company with Sir Frederick Gowland Hopkins, received the Nobel Prize, Christiaan Eijkman died. With his passing away, the world lost a great doctor and a noble friend of humanity. His work will live on in the future as a monument to a great pioneer of the past.

*Hormones and Ovulation**

CLIVE WOOD

In recent years, the popular press all over the world has carried stories about multiple births, three or four, even five or more children being born to a woman all at the same time. Twin births, of course, are not uncommon. Perhaps 1 per cent of all women who conceive can expect to produce a pair of twins. But triplets are rarer and larger numbers of children produced in any one pregnancy are very rare indeed.

WHY then should they be reported so frequently at the moment? The answer is that in nearly all the cases that reach the headlines the woman was originally incapable of having any children at all. But by the use of a group of drugs called gonadotrophins doctors have been able to allow her to conceive, although often she may have conceived more children than she expected. Such treatements have been carried out in Sweden, in Germany and also in England (both in London and in Birmingham), and in some clinics it is becoming an almost 'routine' procedure.

There has been much confusion in the minds of many people about what gonadotrophins really are. They have been hailed as 'wonder drugs' (as is practically every compound used in medicine, at some time or another), and even worse as 'new wonder drugs', although they are far from new. Indeed the idea that such compounds exist dates back to 1926. And in a sense they are not really drugs at all. They are the substances which body itself produces and which can be extracted from it for use on other patients, whereas the majority of so-called drugs are man-made chemicals which bear little relationship to the substances which the body makes for itself.

To understand the gonadotrophins properly we must consider what happens during the course of the menstrual cycle in a normal, sexually mature, fertile woman. The egg-cell that such a woman produces once every month, is, of course, produced in a special organ known as the ovary. The paired ovaries are each about the size of a large walnut and they lie inside the woman's abdominal cavity, close to the uterus (or womb), to which they are connected by the Fallopian tubes.

The surface of the ovary is generally fairly smooth, but at about the middle of the cycle (that is to say about midway between two periods of menstrual bleeding), a number of fluid-filled cysts appear, projecting from its otherwise smooth surface. These are the follicles which contain egg-cells and one of them is destined to grow much larger than the others. At a particular point in the cycle its wall

*Reprinted from *Spectrum*, 82, 1971.

ruptures and the mature egg is released into the Fallopian tube where, if intercourse has recently taken place, it stands a good chance of becoming fertilized. The fertilized egg then moves down into the uterus, embeds itself in the uterine lining and starts to grow and develop into an embryo.

The growth and rupture of the follicle (the latter process being known as ovulation), although it may seem like a random process, is in fact very carefully controlled. And it is controlled by the gonadotrophins. These are hormones or 'chemical messengers' that circulate in the blood stream and exert a very profound effect on certain sensitive tissues with which they come into contact. They are produced by a gland at the base of the brain, which is known as the pituitary, and they are two in number. The two have different actions but both must be present if ovulation is going to succeed.

The first is known as follicle stimulating hormone or FSH. As its name implies, it stimulates the growth of the follicle containing the egg and it plays a part in causing the maturation of the egg-cell itself. However, FSH cannot, on its own, cause the follicle to rupture. That is to say, it cannot induce ovulation. For this to occur the second gonadotrophin is necessary. This is also produced by the pituitary and it is called luteinising hormone or LH Under the influence of this hormone the egg-cell goes through the final stages of its maturation and the wall of the follicle then bursts to release it.

This then is the situation in the normal fertile woman, but not all women are fertile. The causes of female infertility are many and varied. For example, a woman may be unable to conceive because her Fallopian tubes are blocked or because she is 'allergic' to her husband's semen. But some cases of infertility in women are due to the fact that for some reason or the other she is unable to ovulate—precisely the situation that is induced deliberately by the use of the contraceptive pill. And among these women is a small group whose lack of ovulation is due to pituitary failure. In other words, their ovaries do not come under the influence of gonadotrophins. It would seem reasonable, knowing what we do about ovulation, to replace the missing gonadotrophins artificially and hence to restore to them the possibility of conceiving. This is precisely what gynaecologists for the last 15 years or so have been attempting to do, often with a measure of success, but they have not yet succeeded in solving all the problems that the method entails.

First, there is the question of timing. Although a great deal of research has gone on in an attempt to determine exactly when, in a normal cycle, the LH makes its appearance, there is still a certain amount of confusion on this point. And since we do have this uncertainty in the normal situation it makes the problem of knowing when to give the LH 'artificial' treatment doubly difficult. We know that it should be given some time after the start of the FSH administration but different specialists have their own views on exactly how long after it should be given.

Secondly, there is the problem of how much of the hormone to give. Too little FSH will not sensitize the ovary sufficiently to respond to the ovulating effect of LH, but too much will probably produce unfortunate side effects. In

addition to the total quantities to be given there is also the question of the relative amounts of each that are desirable to give the best results. Ratios which are too high or too low may each in their own way detract from the effectiveness of the procedure.

A further complication which we have not yet referred to is precisely what type of gonadotrophin is used. The most obvious source of FSH is the human pituitary, and the hormone is indeed often prepared this way from post-mortem material. But there are also other sources which are easier to obtain. For example, the urine of women after the menopause is rich in the hormone and it is often prepared from this source. This human menopausal gonadotrophin, (as it is called), also contains some LH but in such small quantities that it is said to have no effect.

And what of the LH itself? Again, it could be extracted from human pituitaries but a far more abundant source is to be found in the placenta. At an early stage of pregnancy the placenta starts to produce a hormone called human chorionic gonadotrophin (HCG) which is very similar in its biological action to LH and which is frequently used to replace LH in human therapy. With so many preparations available it is difficult to standardize them all and to decide precisely how much of each one should be given. Again, different clinics have adopted different procedures and it is sometimes difficult to relate the method adopted by one investigator to that used by another.

Despite all these difficulties the treatment of certain types of infertility with gonadotrophins has proved quite consistently to be successful, although a great deal, of course, depends upon selecting at the outset just those patients who are most likely to respond to it. In the ideal clinical situation the FSH is given over a period which depends upon the doctor and the preparation that he is using, and studies are carried out on the patient (for example, studies on the hormones excreted in her urine), in an attempt to discover if her ovaries are responding properly and if a follicle is enlarging. If the answer is affirmative then the HCG is administered to induce ovulation and the patient is recommended to indulge in sexual intercourse on that and subsequent nights in an attempt to fertilize any eggs which might have been released.

Now the greatest difficulty with the method at the moment is an obvious one to which we do not yet have an answer. It is extremely difficult (and some would say impossible) to adjust the dose of FSH so that only one single follicle is stimulated. Even in a normal cycle several of them start to grow together, although only one of them becomes fully mature. The rest regress without ovulating. But in the artificial situation where several have been stimulated, an ovulating dose of HCG is likely to cause them all to rupture. There are certainly enough sperms in the Fallopian tube to fertilize them all and so a multiple birth is likely to result. But the greater the number of babies the lower, in general, is their birth weight and their chance of survival. So, of perhaps five or six children born only two or three may survive.

The two most obvious questions to be asked are : 'will we ever be able to adjust the hormone dosage to exactly the

right level, and if not, is this type of treatment justifiable?

Some specialists believe that the answer to the first question is likely to be negative. Multiple births may always follow the use of these hormones. But the answer to the second question is undoubtedly positive. Many childless couples are prepared to go to almost any lengths to achieve conception and even when the difficulties of this type of therapy are explained to them they are still anxious to go ahead. In this situation the physician who has the drugs, the clinic with adequate back-up facilities and the expertise in this particular field scarcely has any alternative but to proceed, even though, left entirely to his own opinion, he might be inclined to advise against it.

*Helping the Body to Accept Grafts**

JOHN NEWELL

The greatest difficulty in the way of providing spare parts for human beings is still the human body's ability to recognise and attack any foreign material which finds its way into the body. Evolved as a protection against micro-organisms and parasites, this defence system becomes the main limiting factor when the surgical problems involved in transplanting skin, kidneys, livers, hearts, and other organs from newly-dead humans or even from animals have all been solved.

AT present the only commonly used way of getting round the problem is to give doses of immuno-suppressive drugs to patients who have received a foreign organ graft. But the use of these drugs has the serious disadvantage that by damping down the body's defences against foreign tissue it also lowers its defences against infection. Patients who have to be kept on such drugs to prevent them rejecting a grafted organ are, as experience has shown, much more open to dangerous infections than ordinary people. Sometimes they seem more liable to cancer, probably because the body's defence system normally kills off either malignant cells or the viruses which may cause them before these have had time to form tumours.

So although the use of immuno-suppressive drugs can save many lives it is clearly a procedure with serious deficiencies. An alternative approach is to attempt to make the human body accept a foreign graft as though it were a part of the body itself. When this can be done it is called inducing tolerance towards the graft. Sometimes, for reasons which are still unknown, if a small amount of tissue of the same type as a grafted organ is injected into an animal before the organ is grafted into the same animal, then this leads to tolerance towards the organ. Although the technique has been little used so far, surgeons are hopeful that eventually they may be able to use similar techniques to make patients tolerate grafted organs without the need for immuno-suppressive drugs.

However, if this technique is to be used on a large scale then it will be necessary first to discover how tolerance can be reliably induced and so far this has proved impossible since no-one has really known how tolerance works. A new theory put forward in March by

*Reprinted from *Spectrum*, 82, 1971,

Dr. Anthony Allison of the Medical Research Council's Clinical Research Centre in Harrow, together with American scientists of Washington University, has the double attraction of explaining the phenomenon of tolerance in much simpler terms than hitherto and also suggesting how tolerance can be induced to prevent or reduce the need for immuno-suppressive drugs after transplant operations. And there is already a good deal of evidence to support Dr. Allison's theory.

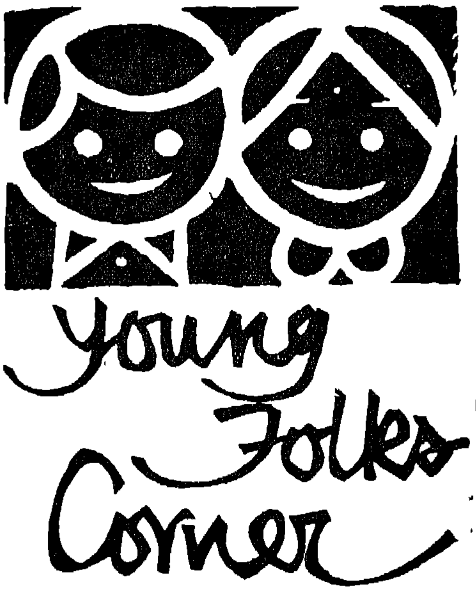
The basis of the theory is that tolerance really comes about not because the body fails to react to the graft but because it reacts to it more strongly than usual. This apparent paradox requires further elucidation. On Dr. Allison's theory the body's defensive reaction against foreign material falls into two parts. First comes the formation of antibodies, molecules specially designed to attach themselves to the foreigner chemically Normally the function of the antibodies would be to neutralise harmful toxins. In the second part of the reaction the foreign material is attacked and literally devoured by the scavenging white cells of the blood, the macrophages. Dr. Allison's belief, however, is that if the first part of the reaction, the formation of the antibodies, is sufficiently strong then the second part will never take place The reason is that if a sufficient quantity of antibodies is produced then these will quite literally camouflage a grafted organ. The antibodies will attach themselves chemically to every part of the organ which is recognisably foreign to the body it has been placed in. And this will mean that there is no way in which the macrophages can recognise the graft as foreign. Therefore, so long as the graft remains covered in a sort of cloak of invisibility, a smoke-screen of antibodies, it will never be attacked and destroyed.

As Dr. Allison is the first to say, much research remains to be done before the idea can be used on a large scale to help grafts to survive. For example, while some antibodies are harmless in themselves, others can damage their graft. Nonetheless one British surgeon has already had some success—first with animals and later with human patients—in promoting the survival of kidney grafts, using very low levels of immuno-suppressive drugs, by actually intensifying the antibody-type reaction against the grafted kidney.

The method used to intensify the reaction was as follows. The patients were children who received kidney transplants from parents. First the surgeon took some blood from one parent of a child in need a kidney transplant and injected this blood into the other parent. This made the body of the second parent produce antibodies to the tissues of the first parent, as a natural reaction to the foreign tissue in the injected blood. Then the surgeon gave the child a kidney from the body of the first parent together with blood serum containing these antibodies from the second parent. This meant that right from the start the child's bloodstream had antibodies against tissue of the transplanted kidney's type circulating in it, as supplied from the second parent. The effect of the extra antibodies—as animal experiments had already shown would be the case—was to make the child's body manufacture even more antibodies of its own against the kidney than would normally be the case. But the effect of all the

antibodies was not to destroy the kidney but to camouflage every single chemical feature of its surface which might have allowed the child's white boold cells to recognise it as foreign—in fact it was protected by the antibodies from destruction.

These ideas have so far only been tried in a few kidney transplants, although the results have been encouraging. But the idea has attractive features in theory as well as practice. Previously doctors had to find some way of explaining why repeated injections of foreign tissue sometimes made humans or animals react to it less rather than more. On the new theory, this acquired tolerance is explained simply as a consequence of one part of the reaction being more violent than usual. This simplification certainly makes the idea enticing to theoretical biologists.



*Frits Zernike : Lenses Were His Life**

On December 10th, 1963 the 65 year old Dutch Scientist Professor Frits Zernike, the man who made living cell visible, received from the hand of His Majesty King Gustav Adolf of Sweden the Nobel Prize for Physics in recognition of his ingenious Phase Contrast Microscope, by means of which it has been possible to study living cells and which has proved to be of inestimable value to medical research all over the world.

AT the beginning of the century, a young student of chemistry, Frist Zernike, attended an auction sale in his home town of Amsterdam. There he purchased a telescope for a small sum. Little did he realize, as he examined the small pieces of glass which were part of his hobby, that they would eventually make him world famous and earn for him the highest scientific distinction accorded to man

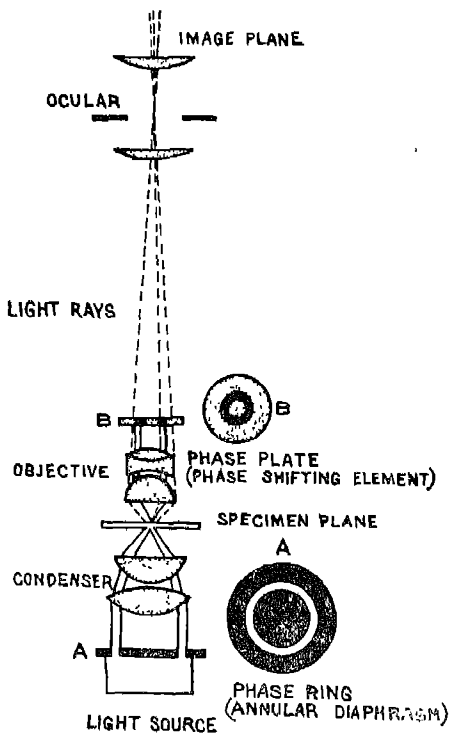
Zernike was known for his perspicacity. The experiments with light and lenses, which were to fill much of his working life, eventually led him to an amazing discovery, the significance of which was not realized immediately but which eventually brought about a true revolution in the optical study of living tissues so minute as to be invisible to the naked eye and in which an ordinary microscope could produce only vague contrasts.

Now, however, thanks to Zernike's phase contrast microscope—which is as simple as it is ingenious—doctors, biologists, bacteriologists, cytologists and histologists all over the world are able to observe living organic tissues and thus, as it were, study life itself as it goes on. Cancer research has probably profited more than any other branch of research from Zernike's discovery.

The unending battle against this disease would probably not have been in such a favourable position as it is today, had it not been for such powerful instruments as the phase contrast microscope. Similarly it has enabled clinical research workers to arrive at a correct diagnosis in a far shorter time. Biologists can now follow the mysterious processes of the division of living cells and cell nuclei; then can observe what is known as "life" in one of its most fascinating aspects. The cell is the smallest of all the component parts of organic life in human beings, animals and vegetable matter. The phase contrast microscope has made it possible to follow the complicated processes which go on inside such a cell while they are going on. An example of these is the activity of the mitochondriae, those minute bodies which form part of the cell protoplasma. All these processes are

*Reprinted from *The Netherlands*, Vol. XIV No. 5, May 1971.

closely allied to the secret of life and to the difference between sickness and health. It is not surprising that the Amsterdam University decided in January, 1953 to award an Honorary Degree of Doctor of Medicine to the man whose discovery had made possible all these strides forward in medical science.



Principle of Phase Contrast Microscope

At the beginning of the 17th century, when the microscope was first invented, no one was aware that disease and illness could be caused by living objects so small that they could not be observed with the naked eye. Once equipped with the then new and wonderful instrument, the scientists of the day rapidly came to the conclusion that the strangely formed organisms which revealed themselves to their amazed eyes and which for the sake of convenience they termed animalcules, might well be the cause of the various plagues which afflict the human race.

No one can say exactly when and where the first lens microscope was made. The philosopher Seneca knew that printed letters became larger, and thus easier to read, if they were placed under a glass bowl filled with water, but it took sixteen hundred years for more systematic lenses to be used to penetrate into the mysteries of the microcosoms. That immensely versatile inventor Cornelis Drebbel, a Dutchman attached to the Court of James I of England, must have possessed an instrument with two lenses and this is still regarded as the forerunner of all microscopes. And yet it was 1800 before the primitive instruments with which a fly appeared to be "as big as a lamb" were improved to the point at which they could be used to pioneer medical research.

Thanks to the work of such great experts as Huygens, Newton, Snellius, Descartes and Abbe, much more knowledge had been obtained in the meantime about the laws of light and the phenomena of refraction. Abbe, who was one of the founders of the world famous Zeiss concern, made a particular contribution to the further development of the microscope into a refined precision instrument without which physics, medicine and technics would never have reached the high level which they have in our day and age. The microscope emerged triumphant in the period between 1878 and 1924. Beginning with Robert Koch, who got on to the track of the cause of infection in wounds, numerous scientists

including Pasteur uncovered the secrets of leprosy, typhoid, cholera, plague, malaria and many other infectious diseases.

Shortly before the outbreak of the Second World War, the microscope took a fresh, powerful step forward with the invention of the electron microscope in which the image was formed not by light waves but by much finer beams of electrons. With its magnification factor of anything up to 100,000, the electron microscope is a large and costly instrument; but it has the disadvantage that living tissues are killed as soon as they are brought into contact with the instrument, while its size and cost place it outside the scope of the individual scientist Long ago the practice came into being of colouring specimens intended for microscope research; in this way they became better visible and displayed the desired contrasts. Unfortunately, however, this defeated the object because living organisms did not survive the colouring treatment.

It took a man of the calibre and versatility of Zernike to break this vicious circle. In his scientific career at Groningen University in the North of the Netherlands, he revealed himself not only as an astute theorist but also as an extremely capable experimenter who was as able with his hands as with his brain. An example of this is seen in his ingenious revolving-mirror galvano-meter with which even the weakest electric currents can be measured. For years this introvert young man, whose interests hardly stretched beyond his scientific activity, worked on an idea aimed at drastically changing the pattern of the light microscope. He extended a theory earlier expounded by the great Abbe on the formation of images. In 1932, he travelled to "the lion's den," the city of Jena in Germany, where the Zeiss factories were located. There his theories were received with interest, but no more, and he was sent on his way with the remark "if what you have said had been of any significance, we should have discovered it by now." The Zeiss research teams were indeed working on the same problem as Zernike. But unlike them, he persevered until he succeeded.

The result of Zernike's pioneering work was seen in a theoretical analysis which he published between 1937 and 1942 and in which he set out the manner in which the image in a light microscope is formed. The waves sent out by the small light source travel transversely through transparent preparations and form an image which can be studied through the ocular lens. But what happens if the various components which constitute the parts of the specimen allow the light to pass in equal quantities? The result would be a vague image lacking in contrast and extremely difficult to analyse. Fortunately, however, the light waves possess a further property; they are not refracted equally when passing through various substances. If you plunge a pencil into a glass of water you will see that it appears to assume a bend, the size of which is determined by the refractory index of water Each element and substance has a different refractory index.

It was this characteristic which Zernike utilised, and as it proved, this was the answer. The greater or smaller "bending" which the various components of a specimen underwent in the microscope caused a phase differential in the light waves; these, however, are not discernible to the naked eye. The following example will serve to illustrate the principle.

A platoon of soldiers marches, in fours,

along a road across which a muddy strip runs at a slant. Soldier No. 1 is the first to encounter the mud and although he continues to march in the same direction he moves considerably slower owing to the resistance of the muddy terrain. Soldier No. 4, however, marches a few yards further before he comes to the strip and thus lengthwise (in the direction of marching) he passes No. 1. The marching ranks have "shifted" in relation to each other; in other words they display a phase differential. Assuming that the road surface and the strip were precisely the same in colours, an aerial observer would still be able to deduce from the shift that the marchers were on 'fast' and 'slow' types of terrain.

The phenomena of refraction and phase shifting are, in fact, considerably more complicated than in our example. However, the comparison does enable us to obtain an idea of the difficulties which Zernike set out to overcome. He succeeded not only in making the phenomenon of phase differential visible but also considerably strengthened it. Zernike's secret lay in placing two objects in the light rays in his microscope, and together these produced the desired effect One of the objects was a metal ring and the other a piece of transparent glass ground to a special design; the former he called the phase ring and the latter the phase plate. This plate was anything but easy to manufacture; above all it had to be slightly thicker or thinner in the centre than around the periphery. The difference was only a few thousands of a millimetre, necessitating almost impossible grinding operation. But Zernike, born instrument maker as he was, conquered this problem too. His perseverance was more than rewarded because, when his new microscope had passed through the stage of "growing pains," the improvement in the detail of the living organisms under the lens was so evident that nothing could hinder the success of the instrument. In fact, Zernike had succeeded in turning the invisible differences in the refractor index into visible differences in the intensity of the light passing through his preparations.

The results were more than surprising. A human sweat gland which displayed only vague lines and shapes when examined under a normal microscope, resembled more a hilly terrain with rivers and gullies when examined under the phase contrast instrument, and the contrasts were clear for all to see.

Shortly after the end of the Second World War, a team of American scientists searching amid the wreckage of the former Zeiss factories came across pieces of a film showing living, moving tissue. The film had been made with the aid of ideas developed by Professor Zernike. One of the finders, the American bacteriologist John T. Bruce, went to Groningen to meet Zernike and invited him to visit America. There, in November 1949, Zernike appeared as guest professor and lectured at the Johns Hopkins University in Baltimore to members of the National Academy of Sciences on his revolutionary theories. In November 1951 he was invited to attend the centenary celebrations of the National Bureau of Standards in Washington where he gave a demonstration at which he more than convinced the scientists present of the value of his discovery. Exactly one year later the famous Royal Society in London awarded him Rumford Medal for his "method of achieving an immense improvement in the observation of fine structures in transparent preparations with the aid of microscopes fitted

with so called phase plates." The Society described Zernike's discovery as the most important in the field of light, made during the preceding two years. Other scientific awards followed, culminating in the Dutch Professor's presence on the dais of honour in Stockholm on December 10th, 1953, to receive from the hand of King Gustav Adolf of Sweden the Nobel Prize for Physics. A member of the Nobel Institute summed up Zernike's life's work as follows "the theoretical conclusions which brought Zernike to his ultimate discovery must be called the work of a genius."

On April 30th, 1954, Her Majesty Queen Juliana of the Netherlands appointed one of her greatest but most retiring subjects to be a Commander in the Order of Oranje Nassau. Professor Zernike more than earned the distinction.

Nicolaus Copernicus

NICOLAUS COPERNICUS (1473-1543 A.D.) was an eminent Polish scholar, creator of the heliocentric theory of the Universe, astronomer, mathematician, economist and physician.

He studied astronomy, law, medicine and theology at universities in Crascow, Bologna, Padua and Ferrara.

In 1503 A.D., after completing his studies, he returned to Poland where he remained till the end of his days. In 1510 he settled in Frombork where he was appointed Canon of the Warmia Chapter. There he conducted his astronomical observations and wrote his main works.

About 1510 A.D. he presented an outline of the heliocentric theory of the structure of the Universe in his dissertation entitled *Commentariolus.*

His most important work which contained a discourse on astronomy based on the heliocentric system, was written over the years 1515-1533 A.D.; it appeared in print under the title *De revolutionibus obrium coelestium* in 1543 A.D. in Nuremberg.

This work revolutionized the then prevailing views on the structure of the Universe and laid the foundation for the new cosmology. Copernicus also displayed interest in problems of economics and in 1526 A.D., he was the first to formulate in a treatise entitled, *De monetac cudendae ratio*, the law of economics according to which cheaper money gradually supplanted dearer: the law was re-formulated by Thomas Greshan, the English economist who lived much later.

Copernicus Instrumentarium

What were the instruments used by Nicolaus Copernicus, the great Polish astronomer who abolished the thesis about the geo-centric planetary system?

Some painters depicted Copernicus holding a telescope. But the telescope was constructed much later, and Copernicus used extremely primitive instruments built on the pattern of the instruments used by ancient astronomers. He obtained with them such accurate results that it amazed the astromers of later times.

What were those instruments? His entire observatory, as it would be called today, consisted of three principal instruments. The first—three flat pieces of wood

with a scale—served Copernicus to measure the angle between the perpendicular and the star. The second instrument was simply a quarter-circle with a scale which also served for measurements.

The most complicated instrument was an equivalent on the modern mobile map of the sky. This consisted of six wooden circles with a scale joined to the same centre so that they could be moved in relation to one another. With the help of such simple instruments the Polish astronomer reached conclusions which have become the foundations of modern science.

500th Birth Anniversary of Copernicus

On February 19th, 1973, the world will celebrate the 500th anniversary of the birth of the great Pole, Nicolaus Copernicus. Recently the 14th Congress of the International Astronomical Union, held in Brighton, Britain, resolved that an extraordinary Congress of the Union will be held in Warsaw in September 1973 to commemorate Copernicus. Apart from several symposia on topical problems of astronomy, a special session devoted to Copernicus will be organized.

An International Congress of Historians of Science will be held in the astronomer's home town, Torun, in 1973.

The Polish Academy of Sciences and Universities in Poland have maintained contacts with research centres abroad, particularly Italian universities, concerning problems of Copernicus and his work. A number of celebrations devoted to Copernicus will be held in Italy during the next three years.

New Trends in Science Education—A Few Guidelines

M Wasi

OUR aim of education is national development This is possible only through industrial, technological and scientific advancement. For such advancement, creative, productive and scientifically thinking people are required. People who may not only imitate but invent their own models and may not only be theoreticians but practical workers.

To produce such citizens is mainly the responsibility of science education. So it is imperative to change the present system of our science education which is based on the old concept of science. It was then defined as systematised knowledge consisting of certain facts, figures, formulae, equations, etc. This definition no longer holds good Now it is not only an organised body of facts and figures, principles and theories but a way of THINKING and DOING things too. Science is not merely what scientists know but also how they think and work. It is a PRODUCT as well as a PROCESS, product of the processing done by the scientists. Process of science also includes the role of scientific enterprise in national development. With this changed concept of science and the role which it has to play, the place of science in school curriculum has to be redetermined. For an industrialising society like ours, it has to be an integral part of our general education.

So far most of our teaching efforts have been directed to the product of science—the content or the factual knowledge. Very little attention has been paid to its processes which are, perhaps, more important as they are not only applicable to science but also to every day life problems. Now attempts are being made to develop such a curriculum in which the PRODUCT and PROCESS may go together. The children may not only know what the scientists have discovered but may also learn to work like them. In U S.A. quite a few programmes of science teaching have been chalked out with this point of view. Two of them, the Science Curriculum Improvement Study (S.C.I.S.) and Science—A Process Appraoch are briefly described in the following pages.

Science Curriculum Improvement Study

Science Curriculum Improvement Study is a research project to develop content-process oriented programme of science teaching for small children. The aims of this programme are:

1. To help the children to learn the fundamental concepts of physical and biological sciences.

2. To enable them to understand that scientific ideas are based on the observation of natural facts and phenomena and are also the product of human inventiveness and imagination.

3. To help them to understand that for an idea to be fundamental and to persist, it is necessary that it is tested against further observation and experiment. If it is supported by fresh evidence, it is accepted and if not, it is either modified or rejected. This programme combines contents processes and attitudes. In fact the three

are interrelated and cannot be dealt with in isolation from one another. Therefore, first the concepts have been carefully selected and then such instructional procedure has been devised which enables the children to learn the scientific process as they proceed on to learn the concepts. This procedure is as follows.

Instructional Procedure. The procedure is based on the modern theory of understanding science which rejects the old idea that a scientist functions only as a camera Instead, it recognizes that the observations depend upon the observer's past experience and the conceptual structure of his mind as much as they do on the object observed. Perceiving is an interaction between what is being observed and what is already there in the mind of the observer. Under this procedure the classroom is converted into a laboratory. Children are given selected material which may be living organism or non-living objects. They are allowed to observe and manipulate the material, sometimes freely and sometimes under the guidance of the teacher. The objectives of the activity and the nature of the material determine the degree of the guidance to be given by the teacher. This is termed EXPLORATION.

The preliminary exploration provides the children with a new experience, a direct physical and mental contact with the organisms or objects. If more than verbal behaviour is desired, this experience is essential. Real understanding is to be achieved through real contact.

The new experiences gained by the children raise many problems which give the teacher the opportunity to introduce the concept. Its understanding helps the child to solve the problems encountered during 'Exploration'. This step is called INVENTION. Here the teacher furnishes him with the necessary explanations and helps him to grasp the concept with more experiments and observations He has to tell the child many things because he cannot be expected to discover what the great minds have done over many years. In the next step which is called DISCOVERY, the child applies the concept to new situations. The experiences provided in this step reinforce, refine and enlarge the content of the concepts. Thus the child not only understands the scientific concepts fully but is also in a position to apply them to solve new problems.

An example will make the three steps clear. Suppose the concept of magnetic interaction is to be developed. For exploration, one of the techniques may be to provide two bar-magnets and a cardboard made skate to each child or a group of children. They are then asked to put one of them on the skate and bring the other gradually towards it. Now some children observe that their skate moves forward while others notice a repulsive action. Curiosity is aroused. They try to find out what those bars are. Apparently they are pieces of iron. The children are then supplied with simple iron bars of the same size and shape. The experiment is repeated with those bars but no interaction is observed The children guess that the two bars supplied at first are different from those supplied later. Why does the skate move forward with the first pair? Why does it move backward in some cases? What is the difference between the two sets of bars. Such questions arise in the minds of the pupils. This step is called EXPLORATION because the children explore the situation they have been placed in.

Now the teacher enters the scene to confirm that the first pair of bars is different from the second, though both are made of hard iron He introduces the name 'magnet' if the children have not pronounced it so far. He shows them how magnet is made. More

experiments are performed. A magnetic bar is suspended so as to move free and it is noticed that the same end points to the same direction when it comes to rest. Then similar and dissimilar ends of another magnet are brought near the suspended bar and repulsion and attraction are respectively observed In this way they find the answers of their questions. Subsequently magnetic interaction with other substances is found out. The magnetic and non-magnetic substances are identified. This step is INVENTION in S.C.I.S terminology.

Lastly the applications of magnetic interaction are studied experimentally in various new situations. This is termed DISCOVERY because something new has been found out with the help of previous experience.

Evalaution: The student is confronted with a set of experimental problems for the solution of which he has to apply the concepts and techniques developed in the unit. He has also to explain why this procedure leads to a certain solution. This is possible for him only if he has well understood the procedure. The problems assigned in this step are different from any that he encountered in the unit. His performance on such problems gives a good evidence of his understanding, initiative and mastery of techniques for two reasons·

(i) The novelty of the problems prevent them from being solved by mere recall of information, and

(ii) the experimental nature of the problems calls for the initiative and grasp of technique.

In this way it can be ascertained how far the objectives of a particular unit have been achieved. This evaluation technique tests the understanding of the concepts as well as the skills learnt or what may be called behaviour acquisition.

Teacher's Role: He treats the classroom as a laboratory where children acqure first-hand experience about natural phenomena and make discoveries. The students are allowed to discuss freely among themselves and also with the teacher but he is careful not to tell what they can find out for themselves. He gives his suggestions only when they fail to proceed to test their conclusions and hypotheses. He encourages them to experiment, to observe and finally to find the answers of their questions for themselves Of course the conceptual structures are provided by him but it is always followed by extensive discovery experiences. He notes the reactions of the students carefully and uses them for planning further science activities.

In fact the teacher's activities determine the curriculum if it is defined as an interactive concept consisting of the developed knowledge of the subject and its relationship to the pupil and his previous experiences which help to clarify learning capabilities.

He has to synthesise the subject and the pupil. This is possible for him for the simple reason that he directly interacts with the children. It is, therefore, imperative for him to know the subject matter he is teaching, the previous learning, intellectual capabilities and maturation level of his pupils. From the preceding description, it is evident that in S.C.I.S. programme the emphasis continues to be on scientific concepts but these are not to be understood through books or verbal explanations but through activities. The performance of these activities enables the children to learn the processes involved. The concepts have been chosen so carefully, the teaching strategy devised so skilfully and the material developed so ingeniously that the children are sure to learn the scientific processes along with the understanding of concepts.

Science—A Process Approach

Science—A Process Approach is a process-oriented programme. It lays a strong emphasis on the learning of scientific processes by the children According to Gagne, the processes of science are what scientists do to gain knowledge. They observe, classify, measure, predict, formulate hypothesis, test them and finally establish new principles. The scientists have learnt these processes by practising over a long period. Gagne, therefore, suggests that the children should be taught these processes in their simple forms from the very beginning If they practise them for many years, they will learn to work like scientists. This line of argument does not imply the purpose of making every child a scientist. That would be futile Instead, the underlying belief is that the functional understanding of scientific concepts is not possible without learning these processes

The other consideration is that, in fact these processes are intellectual skills which generalise in due course of time. Once they have been generalised, they not only help the child in understanding other subjects but also influence his approach to everyday problems. There is sufficient evidence to prove that they do generalise in due course of time.

Piaget's work reminds us that the development of intellectual skills takes place from very concrete and specific to increasingly abstract and general Highly general intellectual skills are formed over a number of years and depend upon the cumulative effects of learning a variety of relatively concrete principles. Accordingly, the skills which the S A.P A. aims to develop begin in highly specific and concrete forms and are gradually generalised by well planned exercises. The whole attempt is very realistic because the objectives of each exercise are modest and hence generally attainable. There is a progressive development of each process category. As this development proceeds, it comes to be increasingly interrelated with corresponding development of other processes. For example, the process of inferring is closely linked with the processes like observing, classifying, measuring, etc and hence the former cannot be learnt until the latter have been practised and mastered. The interrelatedness of this development has been taken care of in the exercises planned for the development of various processes. These have been carefully analysed into eight basic and five integrated processes.

Basic Processes

1. Observing
2. Classifying
3. Using numbers
4. Measuring
5. Using space-time relationship
6. Communicating
7. Predicting
8. Inferring

Integrated Processes

1. Defining operationally
2. Formulating hypotheses
3. Interpreting data
4. Controlling variables
5. Experimenting

A breif explanation and sequence of the development of these processes is as follows:

Observing : The five human senses are fundamental tools of all observation. To develop this process, therefore, the children are placed in situations where they have to use their senses carefully. Gradually they learn that in order to find facts, the use of senses is indispensable. The process begins with identification of

objects and object properties and then proceeds to the identification of changes in various physical systems, the making of controlled observations and ordering of a series of observations.

Classifying : Scientists have classified various natural objects and phenomena in different ways. Sometimes a single characteristic is the basis of classification and at other times many properties are taken into consideration. For example plants have been classified according to their system of producing flowers. Similarly things are classified in everyday life with one or more considerations.

It starts with simple classifications of various physical and biological systems and progresses through multi-stage classification, their coding and tabulation.

Measuring : It begins with the identification and ordering of lengths and proceeds to the rules of measurement of length, area, volume, weight, temperature, force, speed and a number of derived measures applicable to specific physical and biological systems.

Using Space-time Relationship : The problem of space-time relationship arises when things move. They require space for their movement and take time to move from one point to another. For example a car moves on a road and an aeroplane in the air. They may move in straight or curved paths and may also change their directions. Time passes on as they go from one place to another.

Therefore this sequence begins with the identification of shapes, movement and direction and proceeds to the learning of rules applicable to straight and curved paths, direction at an angle, changes in position and determination of linear and angular speeds.

Communicating : The knowledge gained by one has to be communicated to others for its growth and utility. Language is only one of the media which does not always serve the purpose and so other means such as diagrams, graphs, pictures, etc have to be adopted This process development, therefore, starts with bar-graphs and proceeds through describing a variety of physical objects and construction of graphs and diagrams for observed results of experiments.

Predicting : It is based on the observed facts and in the nature of high degree of probability. Every one is familiar with weather forecast, prediction of lunar and solar eclipses. Science has its own methods of predicting which are sometimes very simple but often complex. To children simple methods of predicting are taught like interpolation and extrapolation of graphs. They also learn the methods of testing their predictions.

Inferring : Inferences are based on observations and hence the former are different from the later in nature. Observations are directly concerned with our senses but inferences are related to our reasoning. For example, if a glowing matchstick or a glowing piece of coal is thrown in a gas jar containing oxygen they burst into flames. This is an observation. But if on the basis of this observation it is said that oxygen is a strong supporter of combustion, it will be an inference. Hence first of all the children are taught to distinguish between an observation and an inference and then to draw inferences from observations of physical and biological phenomenons.

Formulating Hypotheses : Hyposthesis is just a supposition which seeks to explain the observed facts. It is based on a few observations and has, as a rule, to

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be tested against further observations and experiments. It persists only if it is supported by this fresh evidence. The difference between a hypothesis and an inference is that the former is a general likelihood in character while the latter is a specific concluded fact. For example if a bulb glows by putting a piece of copper in gap left in a closed electric circuit, the inference is that the copper is a good conductor of electricity. If the same happens by filling the gap with iron and nickel pieces, the hypothesis would be the metals are good conductors of electricity. But for this hypothesis to be valid, it has to be tested against many more metals.

For the development of this process the child starts distinguishing hypotheses from inferences, observations and predictions and advances to the stage of constructing hypotheses and demonstrating their tests.

Interpreting Data : Scientific data are represented in various forms. So this sequence generally begins with the description of graphic data and inferences based on them. It proceeds to constructing equations to represent data, relating data to statements of hypotheses and making generalisations supported by experimental findings.

Controlling Variables : Often there are many factors influencing a certain phenomenon. In order to study the effect of one or a few of them, the others have to be controlled. The first step is to identify these factors and to know their nature. They may be dependent or independent variables. Development proceeds to the level at which the student, being given a problem, an inference or a hypothesis, actually conducts an experiment, identifying the variables and how they are controlled.

Experimentation : This is the crux of the integrated processes. It is developed through a continuation of the sequence for controlling variables and includes the interpretation or scientific experiments as well as stating problems, constructing hypotheses and carrying out experimental procedures.

Coverage of Content : These processes cannot be isolated from the contents of science. But as the emphasis is not on the subject matter, only those concepts have been selected through which these processes can be taught easily. Naturally, the emphasis on processes has resulted in a corresponding de-emphasis on the content Hence the coverage of the content has been reduced and is as follows in various fields of science. Physical Science 40%, Life Science 25%, Mathematics 18%, Earth Science 10%, Social and Behavioural Science 7%

Instructional Material : There are guidebooks, process hierarchy charts, exercises for the teacher but NO LITERATURE IS ADDRESSED TO CHILDREN. There are many exercises for the development of each process. Their sequence has been determined according to the increasing complexity of each process and its relation to others.

In each of these exercises, the objectives have been very precisely and clearly stated in terms of behaviour acquisition. A child is expected to achieve these objectives immediately after the complexion of the activities suggested in the exercise. Each exercise teaches the child some new skills. He is able to do something which he was not able to do before he took the exercise. The pre-requisites and the skills to which it leads, have also been mentioned on the title page of each exercise.

All the exercises are highly structured containing rationale vocabulary, related material, instructional procedure and generalising experience and competency measure. Rationale states the importance of the exercise, vocabulary consists of the new words

that may be useful for the child in doing the exercise and the related material is the list of equipment required for the activities. Generalising experiences are generally group activities designed to enable competency in the child to apply the experience gained in new situations; this measure consists of individual activities aimed at testing the behaviour acquisition of the child. If the child is able to perform these activities successfully, it means he has acquired the desired behaviour and the objectives of the exercise have been achieved.

Distinctive Features

(1) The child has to read no books and has to make no conscious efforts to memorise anything. He learns everything by DOING.

(2) The objectives of each exercise have been stated in terms of the desired behavioural changes to be acquired by the child which can be immediately evaluated after achievement of the completion of the exercise.

(3) Evaluation is the integral part of the instructional programme. Each exercise contains a behavioural achievement test for the assessment of the child. The success at this test indicates the achievement of the goals of the exercise. Besides, separate measures have been developed to determine the pupils' attainments in process-skills prior to instruction so that it may be made sure that they have already acquired the pre-requisite skills.

(4) The learning is cumulative and results in the continually increasing degree of understanding of and capability in the processes of science. Beginning is made in Kindergarten with observation and description of object properties and motion and advances through sixth grade to the design and conduct of scientific experiments on a veriety of topics.

(5) A fairly broad field of science is covered. Topics from maths have been included to help the preparation for other science activities. Principles in Physics, Chemistry and Biology have been fairly represented. There is less of Earth Science and Astronomy but they have not been ignored.

Guidelines for our Programmes

The study of these programmes leads us to the following ideas :

1. At all stages of education, the objectives should be clearly and precisely defined and evaluation techniques to evaluate the attainment of these objectives should be devised. At present, we have just a very hazy idea as to what a student will know and be able to do after he has passed elementary, middle, higher secondary or university examination. Our aims are global for which no evaluation procedures are known with the result that it is very difficult to find out whether or not these aims have been achieved.

2. Yet there is much unnecessary emphasis on 'information' in the teaching of all subjects including science. It has to be diminished and more stress is to be laid on skills and attitudes which may be developed through various disciplines.

3. The instructional programme has to be democratic where students may be free to criticise the teacher, to agree or disagree with him. The classroom has to be the domain of the child and not of the teacher. He has to remain in the background and appear on the scene only when needed. He has no longer to TEACH but to help the child to LEARN.

4. Opportunities have to be provided when children may discuss among themselves and with the teacher. This is essential for their intellectual development.

5. The children's involvement is generally limited to answering questions. This is not enough. The degree of involvement has to be increased according to

facilities available by bringing them directly in contact with the material

6. More instructional material in the form of guide-books, teaching units, text-books, kits and other necessary equipment is to be made available to teachers to improve the quality of their teaching.

7. These programmes have specific indications for teacher education programmes. These must emphasise process-skills instead of theoretical principles of pedagogy. The objectives of teacher-training programmes should be defined in terms of behaviour acquisition of the trainees. There should be less stress on what a teacher KNOWS and more on what he can DO.

The teacher-education planners and administrators have to analyse what a good teacher means in terms of his skills and then chalk out the whole programme in such a way that these process-skills are acquired by the trainees. Evaluation procedures have to be devised for this behaviour acquisition.

After the overall programme has been evolved, each subject teacher has to put such questions to himself. Why do I teach this subject? What is its relation to the total programmes?

What skills, intellectual and manual, are to be developed through my subject and its related activities?

What teaching strategy should I adopt so that my students may learn the desired skills and develop desirable attitudes?

How can I evaluate the outcome of my teaching programme?

The teaching programme of any particular discipline should be developed in the light of the answer of these questions

8. Our educational programme should be realistic, the objectives being modest.

9. Science education should be an integral part of the general education of the child as pointed out in the beginning. Literacy alone is not sufficient. Today our goal should be SCIENTIFIC LITERACY.

Changing Role of Science Projects and Science Club Activities

M.K. GUPTA
AND
P.D BHATNAGAR

From

A method of science teaching and an item of extra-curricular activities.
YESTERDAY

To

The most important aspects of learning science.
TODAY

To

A challenge and gateway for young people to participate in solving major problems of the world of 1980's and a means of developing international understanding.
FOR TOMORROW

THE project method of teaching is familiar to almost all the Science teachers who have undergone the teacher's training. The familiarity is however restricted to a theoretical comparison of this method with others or to a critical note about its advantages and limitations. It is seldom a case, none perhaps

ever reported, where trainees tried project method during practice teaching or after taking position in the school Recently though, there has been a wave of interest in projects because of their being an important item of the Science Talent Search Contest.

Science club activities, their philosophy, scope and practice however have been a favourite set of topics in training colleges and some of them have received favour of being made compulsory during practice teaching and many find place in schools' extra or co-curricular activities.

Thanks to the interest of N.C.E.R.T. and the agencies at national level like National Science Foundation in the past few years which vitalised the interest in science clubs through grants for establishing science clubs, arranging mobile science show and organising inservice training programme for science club sponsors at the Regional College of Education, Ajmer.

The first phase of recent syllabus renovation programme of Board of Secondary Education, Rajasthan in collaboration of a voluntary working group in chemistry at the Regional College of Education, Ajmer, has brought *the science projects and club activities to the foreground* The main spirit and objective of new syllabus is to develop scientific attitudes. The emphasis has shifted from mere developing the understanding and capacity to apply the knowledge, to the development of interest and appreciation leading to the scientific attitude. This emphasis spontaneously emerges from the impact of recent trends in science curriculum construction abroad and in our specific context, conditions and horizons. The great need of bringing the spirit of enquiry and process of science in place of systematised body of knowledge, load of facts has been reflected both in the discipline centred curricula, the discovery and the guided discovery approaches for science teaching (learning).

The instructional material developed for the orientation programme for teacher and the implementation of the new syllabus has been designed to encourage the spirit of inquiry through independent thinking, locating problems, investigations, handling data, suggesting hypothesis, etc.

Projects have been suggested in almost all the units and several demonstrations have been recommended to be presented in such a way as to arouse curiosity and urge to find answers through investigations.

In general the units are suggested to be introducted through observations and results of investigations undertaken by the students. Enthusiastic science teachers will observe that to adopt discovery on the guided discovery method to implement the new syllabus in its true spirit they have to invariably turn to careful planning of the activities of the science clubs. The handbook for chemistry teaching published by the Board of Secondary Education has suggested many activities, their planning and scheme of interrelating them with classroom work.

An attempt is also being made to evolve such evaluation schemes where interest, appreciation and the ability to conduct scientific investigations will be measured. Obviously, then the science club activities and the projects will be the potential sources to provide yardsticks for such measurement.

The importance of these activities has recently been recognised by the UNESCO and an International Conference was organised for the first time at New Delhi in December, 1970, where youth orgnisations engaged in science club activities from Europe, Latin America, African and Asian countries participated. The role of out-of-school scientific activities by young people has been considered in broader prospective of the

problems of the future that the present generation will be facing. It is proposed that through these activities opportunity should be provided to the young generation to participate in tackling the problems like hunger and pollution at their own level. This would develop international understanding, spirit of cooperation, scientific way of tackling problems, anticipating the problems of future and preparing future civilizers of the world by learning the way to solve problems in scientific manner.

It was resolved in the Council meeting of the International Coordination Committee (I.C.C.) for presentation of science and development of out-of-school scientific activities held in December, 1970 that the preparation of scientific documents related to subjects under study serving as working documents and organising youth seminars on the above subjects should be undertaken as early as possible and a final report sent to Brussells by June, 1971. The topics to be covered are suggested as under.

(a) Nutritional aspects of hunger. Basic qualitative and quantitative nutritional requirements of human body under various conditions.

(b) Available per capita food in different parts of Asia.

(c) Green revolution and new methods for increasing food production.

(d) Substitute food materials.

(e) Population explosion and hunger.

(f) Basic questions and recommendations.

It has further been decided that the Asia region should be involved primarily with the topic 'Hunger'.

It is a pleasure to report that line of thinking and the interesting chain of projects perceived year back and already tried out at the Regional College Centre are endorsed by the current thinking at the international level about developing the conciousness towards the local problems and urge the young people to undertake projects to solve them For example the problem of wind erosion, fodder and others connected with the Arid Zone, Western Rajasthan were undertaken by the young scientists from 1967 onwards here.

The basic problems located are:

(1) Shortage and existing conservation of water resources.

(2) Location of new conservation resources.

(3) Wind erosion, movement of sand dunes.

(4) Fuel scarcity, conventional wood or coke being in short supply due to decreasing forest resources and no natural petroleum or coal deposits in this area.

(5) Fodder for cattle : acute shortage during summers.

(6) Fertilizers and fertility of land which is mostly sandy.

A chain of projects was conceived and most of them tried out on the following lines:

(1) To investigate suitable wind mills to lift water for irrigation and to generate electricity for fuel and lighting.

(2) To investigate economy in use of water for fodder production, by trying hydroponic system that does not involve percolation and evaporation wastage in sandy soils and fast blowing winds in scorching sun,

Suitable varieties of fodder grasses, nutrient solution and best conditions for fast growth of these grasses are investigated.

(3) To investigate the use of cowdung for gas generation and utilisation of decomposed material as organic manure in conventional crop growing and cultures and hydroponic system.

(4) To study the sand dune movement and try out the methods suggested by the Arid Zone Research Institute, Zodhm and other agencies.

(5) To study the methods to minimise the evaporation losses from water resources.

The I.C.C. is also contemplating to publish an International Journal shortly in collaboration with Unesco where good projects and activities under the above suggested areas will find place and wide publicity.

A Regional Centre for these activities has been functioning informally under the leadership of Dr. A.N. Bose, Prof. and Head of Science Deptt. and sponsored by the Extension Service Deptt. of the Regional College of Education, Ajmer for the last two years. It is proposed and hoped that this centre will be working as a branch of this international organisation in near future and provide more opportunities to the youth of this region An offer to undertake or assist in the above publication in all possible ways by this centre has been made informally during the recent conference in Delhi. A series of publication 'Activities of Science Club Sponsors' has already been published by this centre for the last two years and has received the attention and appreciation of several Asian countries,

Science, Society and School

DONALD A. CANNAN

Pennsylvian Clearing House on Methodology in Elementary Science, State College, Bloomsburg, USA

MAY be to you it appears to be a bit ridiculous to combine the three Ss above when we all know that the traditional approach in education has been to combine the three Rs 'redin' 'ritin,' and 'rithmetic' which are important, but so are science, society and still the school.

Science can be found in almost every aspect of our lives today, and it permeates our bodies, our minds and mass media sees to it that we don't forget it. Yes, science is here with all its intriguing ways to give us the food for life—but what do we know about it ?

Science comes to us from the past, in a sense it is a form of history. This history was accumulated knowledge that had been painstakingly put down on paper so that the men and women who follow in the on coming generations can make use of the information, gain the good life from its findings, and use the information to guide their thoughts to the future. The knowledge was written in a systematic way so that aspects of science that logically belong together would remain together. To cut down on reading time (something even a speedy reader can appreciate) a form of scientific shorthand, the symbolic fromula, was developed. And, in the end, the knowledge ordered and made concise, was used to establish these principles, laws and truths,

Ask anyone about the law of gravity and he will respond without batting an eyelash. Ask almost anyone to complete the statement "for every action there is .." and he will please you, but perhaps, only after some thought. Ask a limited amount of people what "lox" refers to, and you will be disappointed But, may be a few will remember that it refers to liquid oxygen used as fuel in our nation's rockets.

Aside from definitions, would you rate the society as a whole in their knowledge of science, its attitudes and ways of thinking, as "gifted", "average" or "slow" in science so that they can keep up with the learning taking place in our nation's elementary and secondary schools

By learning, I do not mean "electronics," "cybernetics," or "oceanography." I mean "general science" or, science in general. In the elementary schools, as you well know, many fields of science are discussed and investigated. Here the discussion and investigations are characterized by breadth rather than depth. In the secondary schools, the depth becomes immediately apparent and the breadth decreases appreciably.

This learning also encompasses what is generally referred to as the "scientific attitude scientific method" cloak. This cloth garment is interwoven with problems, methods, observations, conclusions, checking and double-checking, and hypotheses tested and re-tested. The weave just described is reinforced with the wood of responsible behaviour, honesty, the ability to substitute when materials are not available, the desire to record what you see, and critical, yet open minds which adjust to the relativity of truth and new evidence. How can we disseminate this?

Adult education can help many of our "scientific slow learners" out of the rut of living one year's experience with science and life for twenty, thirty, or more years. Science fairs can, if handled diplomatically, reach out and bring in many adults to learn what is new and what is here and now Parents can be invited in ever-increasing numbers into our schools, and not just on P.T A night or during National Education Week. Some teachers with a flair for journalism might begin a weekly science column in a local newspaper to help keep parents (and teachers) up-to-date with recent developments The author runs "The Science Corner" in the Bloomsburg Press each week during the academic year, and has received many enthusiastic comments from parents and teachers. If the teacher has the science knowledge but cannot express himself well in written form, an English teacher might be persuaded to co-author the column.

In short, many different types of activities can be used to help society keep up-to-date with science, help them to better understand the scientific method and appreciate a scientific attitude, and help them to understand that even "scientific slow learners" can improve with time and effort. We, in education, have a responsibility to help keep society informed not just about the end results of science, the inventions, but to aid them in appreciating how science helps us learn and contribute to our lives.

And finally, the problem of the well-informed citizen will take all of the cooperative efforts of teachers and a good local effort to improve society by lifting itself "by its own bootstraps." All of the efforts expended in this direction will serve as indicators of the future in which we will find prepared citizens, citizens who recognize the survival value of knowing and understanding some science, and who will learn to use science for enjoyment and personal satisfaction with an appreciation for the untiring efforts and research which make everything and anything possible at almost any time.

Moon-Rock Clues to Earth's Origin

THE basalt-like rocks brought back from the moon by the Apollo-11 and Apollo-12 astronauts differ chemically in important respects from basalt found on the earth, according to Dr. D.H. Green of the Australian National University's Department of Geophysics and Geochemistry.

The moon basalts were found to be a solidified silicate melt of silicon, magnesium, iron, calcium, titanium, aluminium, sodium, and potassium. The evidence suggests that the contents must have been subjected to temperatures of at least 1100°C before melting and welling up as molten lava from below to flow into depressions on the curst and solidify to form the lunar seas.

By melting samples under a range of pressures in the laboratory the National University Geochemists have been able to make deductions about the moon's interior. The moon basalts appear to have been formed from at least two different melting and volcanic eras, some three-quarters of a billion years apart. Apparently the mantle of the moon was producing molten rock for more than a billion years after the earth was formed.

The Canberra geochemists are now eagerly awaiting the rock samples from the lunar highlands collected by the Apollo-14 mission. Basalt-like rocks from the earlier Apollo missions were from 2·9 to 3 8 billion years old. They hope that the highland rocks will date back to some 4.5 billion years and thus provide clues to the birth of the earth, the moon, and even the entire solar system.

Professor A.E. Ringwood has applied the results of the Apollo moon rock and related long-term research in the Department of Geophysics and Geochemistry to theories of the origin of the earth, the moon, and the solar system. A theory advanced by the National University team is gaining increasing support as the lunar geological project proceeds. Two groups in other parts of the world have developed a similar theory by using the same techniques as used by Professor Ringwood and his colleagues.

According to this theory, the various planets and other bodies in the solar system condensed from a mixture of solid and gaseous material in space, about 4·5 billion years ago. Professor Ringwood believes that the moon itself was probably formed in the later stages of the accretion process from which the earth was formed. At that stage, he suggests, the nucleus of earth was surrounded by a whirling mass of particles and gases not unlike the present rings of Saturn. The particles coalesced and the earth's ring gradually became a single solid body—the moon.

As it gained more particles and grew in size, the interior of the moon began to heat up as a result of the radioactive decay of certain elements. When temperatures reached 1200°C to 1500°C the molten rocks erupted to the surface.

It is possible that the lunar highlands are composed of original crust rocks that to-

By Courtesy : Australian Information Service.

wered above the lava flows. The presence of occasional much older "strangers" among the rocks collected on the lunar seas raised hopes that they were detritus from primitive highland landscapes. These strange rocks were composed of potassium, rare earth elements and phosphorus Their age has been assessed at about 4.5 billion years.

Australian Nobel Prize Winner Warns about "Box of Sorrows"

THE momentum of science and technology is having the same disastrous impact on the world as the intrusion of infectious disease, firearms and excessive use of alcohol into the Pacific around 1800.

Science and technology in the past 50 years has loosed a Pandora's box of sorrows—the population explosion, the genocidal weapons, the plunder and pollution of the planet which seems to be inescapably associated with technological progress

There is a growing sense of futility and despair that calls for drugs and mindless activities to counter it.

After sounding this warning in Canberra recently, Australian Nobel Prize Winner, Sir Macfarlane Burnet said there is hope at the bottom of that Pandora's box.

Science and technology can fashion a stable human ecosystem for earth as easily as man landed on the moon—given the necessary goodwill, energy and imagination on an international scale.

"Only human nature will stop us," he said. Sir Macfarlane gave his directions for the path of survival to the right audience, 1000 scientists from more than 40 countries attending the 12th Pacific Science Congress between August 18-27. Sir Macfarlane delivered the presidential address. Two delegates from India were among about 140 delegates from Asia attending the conference.

They had gathered to further the Pacific Science Association's work of initiating and promoting cooperation in the study of scientific problems relating to the region. More particularly, the association is concerned with the prosperity and well-being of Pacific peoples and also the feeling of brotherhood among the scientists of the Pacific countries.

The Honolulu-based association is an international, non-governmental, regional organisation.

The Australian Governor General, Sir Paul Hasluck, opened the Congress which was concentrating on environmental science and resource management, man in the Pacific, social and legal implications of envirnomental management, and Pacific geology and mineral resources.

Sir Macfarlane Burnet retired in 1965 after 42 years in the laboratory working on infectious diseases. Today he is clarifying his ideas on the field of infectious diseases and writing about human behaviour and aspirations from an almost exclusively biological point of view.

He told delegates that it was not European civilisation as such that harmed the Pacific, but three lethal agents that over 2000 years Europe had learnt to live with, and these were:

Infectious Diseases: In any community that can maintain adequate public health services, infectious diseases arising naturally will never significantly affect population totals.

Deliberate or accidental manipulations in laboratories dealing with microbial genetics could be the only source from which new infectious diseases could come to disrupt life as they did in the Pacific.

By Courtesy: Australian Information Service.

..e doubts whether microbiological weapons for large scale war will ever be developed, simply because of the practical difficulties of confining their action to the hostile population.

Accident, however, can kill as effectively as malice. The study of the genetics of viruses potentially harmful for man will always be dangerous and should cease.

Nuclear Weapons: Once the doomsday bombs are loosed on a large scale, civilisation is probably doomed and the regeneration of the species may take far more than the 100 years it took the Pacific to recover from the fatal impact of the Europeans.

Alcohol and Drugs: Alcohol is responsible for or at least associated with much physical illness, a great deal of crime, including, in Australia at least, most murders and perhaps half the road deaths.

"We have always found ways to keep alcohol under some sort of control while, without often saying so, accepting its necessary role in softening the impact of too many people and their antagonisms on the average individual. Primitive races exposed to similar pressure find alcohol even more necessary and sink more readily into degradation"

It is sinister that all over the world new addictions to synthetic or semi-synthetic drugs are developing and building degenerate subcultures, in a fashion only too reminiscent impact of alcohol on the South Seas.

"The whole world of the Pacific Islanders was shattered to pieces around 1800 by the intrusion of things unthinkably different, to which their cultures could not adapt. The essence of my parable is that the momentum of science and technology is having the same disastrous impact now on the world as a whole."

More optimistically, Sir Macfarlane said, may be things are not as bad as they seem to an introspective biologist in 1971.

Just before the year 1000 A.D. men were equally certain that the end of the world was at hand, yet the world did not end.

In fact within 50 years there was a resurgence of the human spirit to end the Dark Ages in Europe.

Perhaps the year 2000 will mark the end of another dark age and the beginning of that balanced global ecosystem that must eventually be built.

Sir Macfarlane said that however unlikely it may seen, that can give us something worth working for, something that may keep us from lapsing too soon into an apathetic acceptance of our destruction.

Replacing Missing Enzymes

THROUGHOUT the world thousands of people suffer from incurable diseases caused by genetic defects, faults in the DNA blueprint which controls the structure of every single working part of the human body. A fault in any part of the DNA code leads to the repeated production of a faulty molecule just as an inaccurate blueprint used by engineers, if faithfully copied, would lead to the making of faulty machinery.

In living things most of the defects which occur in DNA result in the product of faulty enzymes. Enzymes are the body's chemical machine tools responsible for catalysing all the many thousands of vital chemical processes involved in life. A defect in just one enzyme can be the cause of a serious disease, and this kind of disease is nearly always incurable and can even prove fatal.

Reprinted from *Spectrum*, **82**, 1971.

Now two British doctors, George Gregoriadis, and Brenda Ryman, of the Royal Free Hospital in London, have developed a technique which within a year is likely to be used to cure some of these diseases. The basic principle which has already been very thoroughly tested in rats, though not yet in humans, is to obtain the correct version of the missing or defective enzyme from an animal, and then inject it into the patient's body to make-up his or her deficiency. However, the practical application of this principle is not so straightforward

What actually has to be done is to supply the missing enzyme in the form of millions of microscopic capsules, each consisting of a minute dose of the vital enzyme surrounded by a protective sheath. The enzyme, Gregoriadis and Ryman have been working with, is one which helps the human body to store surplus sugar in the form of glycogen. It is called amyloglucosidase and in normal people it is found in the liver where sugar carried there in the bloodstream from the disgestive system is converted by the enzyme into glycogen. Using rats, doctors have prepared a solution of amyloglucosidase and have mixed this with another solution of the fatty compounds known as lipids. Through years of experiment, the researchers developed solutions which, when mixed together in this way, were automatically split up and formed tiny "micro-pills", each one consisting of a tiny dose of enzyme with a spherical coat of lipid automatically gathered round it. Injected into the bloodstream, these microcapsules travel unharmed to the liver—unharmed because the lipid coating protects the enzymes inside and also, being a very simple compound, it is not recognised and attacked as foreign by the body's defence system. Once in the liver, the protective coats are stripped off the microcapsules releasing the enzyme in sufficient quantities to repair any deficiency, at least temporarily.

The success of the experiments on rats has been such that human trials are likely to begin well within the year, and there is no reason to suppose that the technique will pose any additional health hazards. The limitation to the technique is, and will be, that the foreign enzymes have only a limited span of useful life in the human liver before they are destroyed by the liver cells themselves. This would mean that repeated injections would have to be given to a patient throughout his life. But the advantages provided by replacing the missing enzyme—and there is no reason why the same technique could not be used for virtually any other enzyme which may be deficient—would make such treatment well worthwhile.

The great advantages of this technique lie in the lipid coating on the microcapsules. Other laboratories working along similar lines have used artificial nylon coating, however, nylon tends to be recognised and rejected as foreign by the body

This technique should not be confused with the much more distant and radical concept of curing genetic disease by genetic engineering. Many laboratories are working towards the correction of faults by replacing damaged and faulty genes by sound ones. Some biologists believe that eventually it will be possible to do this by attaching the right form of DNA to a virus and then infecting whichever part of the body needs it with the virus Unlike the technique developed by Dr. Gregoriadis, this genetic engineering would offer a once-and-for-all cure, but it is much further off than his technique, which he sees as filling the gap between today's merely palliative treatment and the coming of genetic engineering.

New Catalyst may Solve Car Pollution Problem

JOHN F. WEBB

A DRAMATIC reduction in the poisonous content of vehicle is promised by discoveries made by the giant Imperial Chemical Industries (ICI) group.

Incorporated into a new type of exhaust system, the two new catalysts that have been discovered, effectively are said to reduce by 97 per cent The carbon monoxide emitted, while hydrocarbons are reduced by 98 per cent. More important still, the oxides of nitrogen discharged into the atmosphere are out by 90 per cent.

This means that a catalyst equipped car or lorry will meet through new anti-pollution standards set in the United States and other countries for 1975 and 1976.

Vehicle makers are faced with increasingly tough controls on exhaust emissions as countries seek to cut pollution Until now, no catalysts have been successful in removing the most poisonous element of a vehicle's exhaust.

By Courtesy. British Information Services.

Because of this, manufacturers have been developing expensive mechanical systems that re-cycle the exhaust gases to control the amount of carbon monoxide and unburned hydrocarbons that is discharged. Although such systems can cost up to £100, they all failed to remove the highly poisonous oxides of nitrogen without impairing the vehicle engine's performance and efficiency.

By comparison, a simple control device using the above catalysts could be built into a vehicle silencer at an extra cost of something like £30. With mass manufacture this could be reduced.

A comparatively small and simple catalyst system has already been successfully tested in a Morris Marina saloon car More elaborate durability trials are now to begin with Marina saloons.

These tests, which will take place over the next three months, will seek to establish that the catalysts have a working life of at least 50,000 miles. They will also check ICI's confident claim that the new catalysts will not be harmed if an engine misfires and they are sprayed with unburned petrol. This has been a problem with earlier catalysts because the petrol causes the catalysts to overheat.

I. Curriculum Development

Primary Science Project (UNICEF)

THIS is a continuing project. Instructional materials and teaching aids for classes I to IV have already been prepared earlier and made available to the States for adaptation/adoption, and translation into regional languages for use in the pilot project schools. The adopted and language versions of these books were prepared by the States of Gujarat, Maharashtra, Andhra Pradesh, Kerala, Jammu & Kashmir, Punjab and Mysore. They are being used in the experimental schools in the respective States. The class V textbook has been mimeographed and sent to all the non-Hindi-speaking States for adaptation and translation for use in their project schools. The first draft of the Teachers' Guide of class V textbook has also been prepared.

Two pamphlets were developed for evaluating class III and class IV textbooks for Primary Science and these have been sent to the States.

Study Groups

This is also a continuing project. In the last phase of the project excepting the Conveners' Group in each subject all the other groups in Chemistry and Biology have been dissolved. The Conveners' Groups in these two subjects are now finally preparing their senior school materials ready for the press. The groups in Mathematics and Physics are continuing and will complete their materials for the senior stage in another year's time.

Project on Improved Teaching of Science at Secondary Stage

This is also a continuing project which is receiving UNICEF assistance. Till last year all the materials for middle school stage had been completed and their first revision has also started. Now it is envisaged to produce draft materials for the first two years of the high school stage. At present the material for first year alone is being prepared.

II. Ancillary Curriculum Projects: Production of Filmstrips, Films and Kits

The materials prepared under this project are related to the overall curriculum development. A film on the 'Teaching of Primary Science' has been prepared for use in Teacher Training Programmes and 100 copies of this film are being made both in English and Hindi for supply to the key institutions under the Unicef assisted pilot project Another film on 'Teaching of Physics' is in progress. Preparatory work has also been started on developing a script for another film on 'Primary Science' which would cover one of the major content areas included in the syllabus.

Two sets of slides on "Primary Science Teaching" and "Teaching of Science" were prepared and sets of these have been sent

to about 100 teacher training institutions throughout the country.

III. Training Programmes

The Department of Science Education continued to provide instructional materials and training for the key persons for the Unicef assisted pilot project on the improvement of science teaching at the primary and middle school levels So far 15 States and two Union Territories have started implementing this project on a pilot scale in 50 primary and 30 middle schools each. The project is now in the second year

Orientation Course for Key Personnel from Eastern States

An Orientation Training Programme for the Key Personnel of the State Institutes of Science Education of the Eastern States was organized. Representatives from Assam, West Bengal and NEFA attended the course. The main objective was to acquaint them with the content of the philosophy and the approach of the instructional materials developed at the Department of Science Education for the teaching of science at the primary level and science as Physics, Chemistry and Biology at the middle level. Fourteen participants were acquainted with the use of the several kits. Four participants from the Delhi Corporation also joined the course.

MAHARASHTRA

A ten day programme for teacher educators at the State Institute of Science Education at Poona was organized. One officer acted as resource person at this institute.

HARYANA

An Inservice Training Course for middle school teachers was organized by the State Institute of Science Education at Karnal. Two persons of the Department acted as resource persons.

One week orientation programme for teacher educators in Science and Mathematics from the States of Punjab, Haryana and Himachal Pradesh was organized to discuss their plan for the new B.Ed. syllabus to be adopted by the Universities of the States. This training programme was organized in collaboration with Department of Teacher Education. And it was assisted by all subject experts of the Department.

NAGALAND

A 10-day workshop was organized by the Government of Nagaland at Kohima in April-May 1971 In this workshop the key personnel of the Department of Education in that State were trained to work for the pilot project. Shri S. Doraiswami and Shri K. J. Khurana acted as resource persons at this workshop.

RAJASTHAN

A workshop of science teachers and training college lecturers was organized at Udaipur which was assisted by two resource persons from the Department, viz. Dr. B.D. Atreya and Shri S P. Sharma.

PONDICHERRY

A 10-day training programme for the science teachers of the Union Territory of Pondicherry was organized in July 1971. Two officers of the Department, viz. Dr. B. D. Atreya and Shri K J. Khurana acted as resource persons.

IV. Central Science Workshop

Central Science Workshop continued to work both on the development of proto-types of science equipment as well as batch production of a number of kits for use under

the pilot project for the improvement of science teaching.

(i) Physics No III for use in the 3rd year of the middle schools.

(ii) Biology Demonstration Kit for middle school stage

(iii) Chemistry Demonstration Kit for the middle school stage.

(iv) Physics Pupils Kit No. I

(v) Chemistry Pupils Kit for the middle school stage

(vi) Ten sets of Study Kit based on materials developed by the Study Groups for try out in three experimental schools.

(vii) Five proto-types of Mathematics Kits for Classes VI, VII and VIII.

(viii) Drawings for Physics Study Kit No. II.

Under the batch production following number of kits were taken up

(i)	Physics Demonstration Kit No 2	750
(ii)	Chemistry Demonstration Kit for middle schools	600
(iii)	Biology Demonstration Kit for middle schools . ..	600

150 kits of each of the above have so far been supplied to the pilot schools of 5 States, viz. Rajasthan, Gujarat, Uttar Pradesh, Madhya Pradesh and Mysore.

Above 1000 primary science kits out of 1250 that were batch produced in the previous year were supplied to the experimental schools at various stages under Unicef pilot project.

The Central Science Workshop assisted the National Small Scale Industries Corporation and the Unicef in finalizing the designs of the various kits for commercial exploitation.

V. National Science Talent Search Scheme

This is a continuing programme. The examination for the current year was held on 3rd January, 1971, at 330 centres. About 8000 took their test Ten interview boards were organized in May for interviewing about 1000 candidates in different cities of the country. About 358 candidates were selected for award of scholarship of which about only 200 have joined the approved institutions The total number of scholars receiving the NSTS scholarships at different levels now number over 1,200.

Eighteen summer schools were organized during the month of May/June 1971 for the under-graduate scholars at different university centres About 700 awardees participated in these summer schools More than 200 awardees of the post-graduate level worked on research programmes in 25 laboratories of advanced centres or in different university departments

The scheme for examination for 1972 has been advertised in all the leading newspapers throughout the country. Over 38000 application forms have been issued to institutions and individuals.

VI. Summer Science Institutes Review Committee

The task of organizing the summer institute at school level has been transferred to the NCERT from the current year. Before undertaking this the Council set up a high power committee to review the impact of science institutes organized so far and to suggest ways and means for making them more effective and functional in future.

The committee met at several places and they have now submitted their final report. It is intended to give a large measure of administration in organizing these institutes to the different State Directors of Education.

VII. Inter-departmental Programmes : Seminar on Population Education

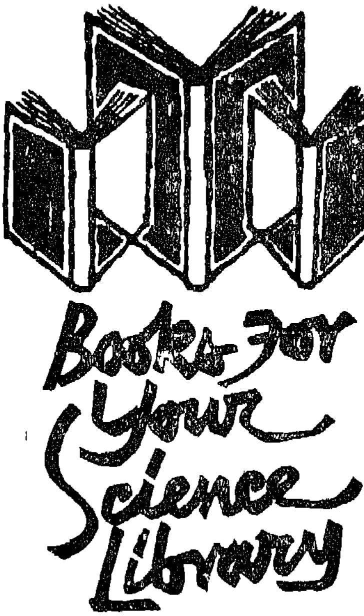
Shri S. Doraiswami was nominated from the Department of Science Education for participation in this seminar.

Dr. M. C. Pant and Shri N. K. Sanyal assisted a preview session of the Chemistry filmstrips to scrutinise and review nine film-strips. The final script and foreword for the manuscript on 'Portraits of Scientists' was prepared in collaboration with the Department of Teaching Aids.

VIII. Visitors to the Department

The following visitors came to the Department and the Central Science Workshop.

1. Major T.S. Khera of Army Education Corps.
2. Col. Deengar, Army Education Corps.
3. Dr. Gareth Howeell from British Council.
4. Dr. R.M. Drummelan, Associate Expert on Educational Research, UNESCO Regional Office, Bangkok.
5. Madam G. Masolova, former UNESCO Expert to the Department of Science Education.
6. The awardees of National Teacher Awards, 1971.



BIOLOGY TEACHERS HANDBOOK

Second edition

By Evelin Klinkman

Supervisor

Wiley Eastern (P) Ltd., New Delhi

THE Biology Teachers Handbook was first published under the supervision of Dr. Joseph J. Schwab in 1963 as part of the series of books prepared under the Biological Sciences Curriculum Study Group in USA. This handbook for teachers was very widely used in India also, by the inservice trainees in the Summer Institutes Programme and they found this book very useful. The tasks undertaken in the preparations of the original book were four In Section I the character of the BSCS approach to biology was indicated In Section II a special kind of teaching material designed to serve one of the objectives of the BSCS—the teaching of biology as enquiry—was provided. This novel method which was in the form of discussion between the teachers and the students or teacher trainees was very useful in inculcating the spirit of enquiry in the teaching of biology subjects. In Section III the book provided the teacher with a knowledge of other subjects other than biology but necessary for the teaching and learning of modern biology. Section IV and V provided information and materials that may be of assistance to the teacher in the day-to-day teaching of modern biology specially the BSCS materials

The second edition was designed to make this book more useful for teachers preparation. In Section I besides a complete description of the character of BSCS approach, descriptions of many types of materials that have been produced and revised by BSCS since the publication of the first edition have been given. Section II includes in the revised edition an index to the invitations which would facilitate their use. Section III has been expanded to include the terms of suggestions for teaching Biology and emphasizing the activities designed to assist teachers in developing enquiry approach to the teaching. Section IV which deals with background material has been reviewed and revised to bring the materials consistent with current knowledge in various fields. Section V consists of appendices which are useful to the teachers. In Appendix 1 are published certain research papers in biology. These papers being available in one place is of great use for teachers of biology They get an opportunity to read these papers in one book, instead of hunting for them in various libraries. This is a distinct advantage in India where the biology teachers in small towns will not have any library facilities. Appendix 2 gives a selected bibliography for teachers. These bibliographies would be useful both for pre-service and for inservice training.

Laboratory facilities for BSCS Biology is described on page 623 which gives designs for laboratory workrooms as well as details of equipment installation, etc Section IV is important as it deals with "techniques and materials for the biology learning." This gives the formulae of solutions, reagents and the useful values of other instructions for the teacher, who is isolated in a place away from any university centre or other places from where he alone can get such information in this country. Section V deals with sources of films etc. and Section VI indicates career opportunities in the biological sciences.

On the whole the second edition of the Biology Teachers Handbook would be a great asset in the library of our Key-Teacher Training Institutes like State Institutes of Science Education, Training Colleges for Teachers and Training Schools for Teachers, and in all high schools where biology is taught in a modern way. The book will find a demand by wide field of biology educators.

By bringing out the Wiley Eastern edition the cost has been lowered and it would be within the reach of the institutions mentioned above, particularly when we think of the price of the original edition which was $ 8.95 much beyond the reach of our ordinary schools in India By bringing out this low cost edition the Wiley Eastern (P) Ltd. has done a good service for Biology Education.

BIRTH CONTROL

By Garrett Hardin

Society Series, BSCS, Wiley Eastern (P) Ltd., New Delhi, 1970

The Biological Science Curriculum Study after preparing several materials for the different versions of the Biology courses are also bringing out several useful and important Supplementary Reading Materials which have a close relationship to many topics dealt with in their textbooks. There are some topics details of which cannot be introduced in a regular modern textbook which is actively oriented. One such topic is birth control. The book "Birth Control" by Garrett Hardin under the Science and Society Series and the editorship of BSCS is a good supplementary reading material on the topic.

In India programmes under Population Education and Family Planning are receiving great attention. Science has a big role to play on the problems of Population Education and what is taught under science will have a great impact on the students of the present day. In a recent conference of state level workers on Population Education it was stated that sex education or human reproduction cannot be taught in the classrooms in India in the same way as it is being done in the permissive society of western countries. What is openly stated there would be objected to by the public and even the teachers under the Indian conditions So, human reproduction has to be taught in a more subtle way, only giving facts of science. The same argument can be used in the case of the matter to be included in textbooks meant for Indian children. It is in this context that the utility of easily understandable non-technical supplementary materials becomes important. What cannot be taught openly in the classroom can be learned through these books which must be made available in the school libraries. Everyone is agreed that a knowledge of human reproduction and family planning including birth control is necessary for every teenage pupil. "Birth Control" by Garrett Hardin gives good account of the subject. In about 142 pages the author explores the myths, taboos,

attitudes and ethics of the subject. After a brief review of the pertinent aspects of the biology of sex, various techniques of birth control are presented along with their limitations, constraints and unknowns. The topic of abortion receives a more extended treatment.

"Is Birth Control for me?" is a question that every responsible individual must answer for himself. But it is a question that should be answered only on the basis of knowledge of scientific facts of birth control and this includes understanding of the modern and psychological problems of birth control. This straightforward guide by a noted biologist offers both.

Prof. Hardin believes that every child should be a wanted child, both for the sake of the parents and for the sake of the child. His principal aim is to help the reader to make up his own mind on the basis of sound information and hard thinking.

The book would be a useful addition to any School Science Library. With books being prepared on modern lines including modern concepts, the arrival of this book is very timely It would help the person who writes textbooks to choose materials to be included under this subject.

SYMBIOSIS: ORGANISMS LIVING TOGETHER

By Thomas C. Cheng

Pegasus Topics in Biological Science, Biological Sciences Curriculum Study, Wiley Eastern (P). Ltd., New Delhi 1970

The "small monograph" is not intended to be a textbook or a comprehensive treatise on the subject. It introduces the subject in a simple manner and includes some basic concepts and principles as related to symbiosis with emphasis on endoparasitism. It provides selected data both observational and experimental which exemplifies these concepts and principles. The book is intended for students of Biology as well as layman interested in the subject. Consequently only a few technical terms are used and ample background information is provided

Examples selected from the realm of human and economic parasitology have been included without emphasising the medical aspects of the discipline.

A perusal of the contents shows that the book deals with types of symbiotic relationship, the origin of symbiosis, where they live and how they adapt, etc. It also deals extensively with symbiosis and human welfare. This chapter deals with protozoan parasites, some tremetodes and tapeworm, etc. By dealing with the subject in relation to human welfare it will also act as a good Supplementary Material on Health Education. This book would also be a very useful addition to any science library in the secondary schools.

S. Doraiswami

Search for a Syllabus for Elementary Physics Course

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Introduction

IT IS well known that the economic and cultural progress of a country depends largely on the development of its science and technology. Because of this strong interdependence teaching and research of the basic sciences constitute an essential pre-requisite of high priority in the development plan of every country. It is no wonder, therefore, that most of the industrially developed as well as developing countries are spending a sizable part of their national effort in improving the quality of science education.

Objective

What should be the objective of a well-planned science education policy? Obviously, it must not only help people to adapt to their existing environment but it must be versatile and flexible enough to prepare them for the age of science in which social patterns are continuously and rapidly changing. This in turn connotes that the teaching process should aim at developing a 'science attitude', enabling the students to extrapolate their knowledge logically to meet the challenges of any exigency. Traditional science teaching, which is examination oriented and therefore gives more emphasis on memorising facts rather than on their analysis through experiments and observation, is, therefore, altogether unsatisfactory. New curricula, based on well-planned syllabi satisfying this essential criterion of laying a premium on stimulating the spirit of discovery must therefore be formulated on national as well as local levels. We have studied the school syllabi in physics in use in different States of India in the light of analysis given above.

Analysis of the Curricula Currently Followed in Indian Schools

In this analysis the following aspects have been kept as guidelines.

(a) Development of logical chain of the subject matter;

(b) Emphasis on investigative approach rather than on "chalk and talk" approach;

(c) Suitability of adoption under the existing Indian economic and social conditions;

(d) Incorporation of the study of problems that the children come across in their daily experience;

(e) Illustration of the essential unity of the different disciplines of science through the application of physical principles to other sciences.

It should be noted here that it is the usual practice to draw up a skeleton syllabus unaccompanied by notes indicating their underlying philosophy. This practice leads to the publication of books of widely varying standards including cheap 'note-books' which cover the syllabus in a literal sense and do not reflect in any way the basic motivation which led to the formulation of the syllabus. A much better practice would be to publish the syllabus along with textbooks, workbooks and teacher-guides etc. which will act as standards for prospective authors.

In the primary stage, in our opinion, the first few lessons should be devoted to the measurement of length. After all, measurement of length is the basis of most of the processes to be developed later in physics A scale is a simple but effective instrument which will retain its utility throughout the life of the pupil both inside and outside the laboratory. Since wooden or plastic scales can be mass produced at a very low cost, even in an economically handicapped country like ours, it is possible for every single student to possess his own scale Further, measurement is an activity which requires doing something and at this young age, 'doing something' is more interesting than 'being shown' something Hence from every point of view, it is desirable that the study of physics should begin with the study of length followed in logical succession by those of area and volume Unfortunately, this procedure has not been adopted by many of the States. No explicit mention of the measurement of length has been made in the syllabi of Andhra Pradesh, Assam, Bihar, Gujarat, Kerala, Tamil Nadu, Mysore, Tripura and West Bengal. The syllabus of Maharashtra takes it up at the end of the fourth year (Class VIII) of science education. In Madhya Pradesh the subject is taken up at the end of the first year (Class VI). In Rajasthan it is discussed in the second year (Class VI). In Orissa alone, the study of physics begins with the measurement of length. In Uttar Pradesh the measurement of volume is taken up in the earlier part of the syllabus, but those of the length and area are not mentioned at all. In all these syllabi, there is no indication of the activities to be performed by the students themselves. In the absence of standard textbooks of the type mentioned above, it is apprehended that no importance will be attached to direct participation of the students in the study of the subject.

It is felt that once the basic process of the measurement of length has been explained, the students would be ripe enough to grasp the idea of a graph. In actual pilot-scale field experiments carried out in Calcutta, this expectation has been borne out. Again, supply of graph papers to individual students costs little and is feasible from the economic point of view.

The next logical step is obviously to develop the idea of measuring time. Only in the syllabus of Maharashtra, there is mention of this topic. Since stop-clocks and stop-watches are rather costly, the hesitation for the introduction of time measurement in elementary schools is understandable. However, the measurement of time is a 'must' in any really useful course in physics and alternative approaches through the use of hour glass, water clock, simple pendulum, model escapement wheel and other devices should be tried.

The concepts of speed, velocity and acceleration should follow by associating the concept of length with that of time. This development has to be carried out through numerous examples from everyday life, through classroom demonstrations and principally through experiments to be carried out by the students themselves. In none of the State syllabi these topics have been considered. As a result, these fundamental dynamical concepts are imparted to the students only as mathematical exercises in the 'mechanics' course at the secondary stage in many States. Students taking these courses, therefore, do not experience the physics behind these fundamental concepts.

In the development of the logical chain under consideration the next links in order are force, weight, gravity and mass.

Once these concepts are mastered, the students will be in a position to study different physical phenomena. We find that most syllabi have neglected the development of this solid foundation upon which the whole superstructure of physics can be built securely. Special attention should be given to the concept of mass. In most textbooks mass is treated as the quantity of matter contained in a body. This definition serves no useful purpose since matter is defined as something possessing mass. Moreover, living as we are in the age of relativity, the concept thus introduced will cause needless confusion later. A better way of defining mass will be in terms of resistance offered to changes in the state of motion. In none of the State syllabi, this approach has been indicated.

Since the time at the disposal of the students is severely limited, all extraneous matter should be removed as far as possible. It appears that the formulators of the State syllabi are almost always fond of introducing physics through hydrostatics and its various ramifications rather than through mechanical concepts. We do not think that this roundabout approach is at all necessary and our experience with children indicates that they are universally fond of studying moving things. It is only necessary to mould this natural bent of mind, by means of experiments of very simple types, to enable them grasp the basic mechanical foundation of physics as noted above. Knowledge of a student in mechanics should be supplemented further by the ideas on particle structure of matter. Living as we are in the atomic age, many of his queries and questions will remain unanswered unless he is familiar with simpler ideas on the constitution of matter. 'Molecule', 'atom', 'nucleus', 'isotope', 'electron', are becoming familiar terms in daily lives, and their explanation to students will undoubtedly make the concepts less mystic. Once a student is at home in mechanics, his mind will be ready and flexible enough to accept the ideas of particle structure if help is taken of well-thought models. In syllabi of some of the States like Andhra Pradesh, Assam, Maharashtra, Madhya Pradesh, Tamil Nadu, Rajasthan and Uttar Pradesh, matter and its three states have been mentioned but none of them has mentioned anything about the constitution of matter.

Another topic which a student is expected to know at this stage is 'Energy'. Most of the students have seen uses and application of various forms of energy in and outside home. Disjointed references to heat, light, electricity, sound, magnetism etc. are to be found in the syllabi of most of the States, without stressing their essential unity through the concept

of energy. The physics curriculum prepared by the Assam State only has attempted to explain 'energy' in a logical manner and in it there are references to the kinetic and potential forms of mechanical energy. It is strongly felt that stress should be laid on the unification of concepts at an early stage giving a wholesome and compact view of physics.

Efforts made by NCERT

The above analysis shows that the different syllabi now followed in the different States do not convey to the students the basic fundamental principles of physics in a logical manner. This deplorable condition of school science education in our country has been a cause of headache to the Government of India. The National Council of Educational Research and Training in collaboration with the University Grants Commission convened a conference of top-ranking educationists of our country in Delhi in April, 1966 under the Chairmanship of Dr. D.S. Kothari, Chairman, University Grants Commission. A report on the present position of science and mathematics in our school curriculum was submitted by the National Council of Educational Research and Training before the conference. In the report the Council said "The curriculum is for the most part out-dated and does not include modern concepts and understandings of science. No organic relationship exists in the teaching of biological sciences, physical sciences and mathematics : each falls into a separate compartment. The textbooks used are of poor quality and teachers are not provided with manuals, guides and other instructional materials. Laboratory apparatus and equipments are of the antiquated conventional type unsuited to teaching science along modern lines". The National Council of Educational Research and Training presented a draft plan before the conference. The plan was discussed and the conference arrived at the following conclusions :

(i) Improvement in the total standard of science and mathematics is a continuous process that demands three integrated steps and the process must begin necessarily at school level. It should be developed as follows :

(a) Development of the curriculum that includes modern concepts and understandings of the subject-fields and a rigorous analytical study of fundamentals.

(b) Preparation of textbooks based on the new curriculum, teachers guides/manuals and other instructional materials, experimental kits and improvised apparatus.

(c) Training teachers and equipping them with the necessary competence to introduce the curriculum in the classroom.

(ii) The preparation of teachers and curricular materials is a cooperative effort in which university professors and first-rate scientists must work closely with science teachers in schools. A stage has come for India when our university professors and school teachers must meet at professional level for the interchange of experience and knowledge. University professors and professional scientists must understand the problems of school teachers and help in improving the standard and quality of science education. For this purpose, a number of study groups should be set up immediately at selected universities and other institutions of higher learning. A long term programme for the

above must be formulated and implemented in close cooperation with the State Governments. In the formulation and implementation of the programme, university professors and professional scientists must play a leading role and offer their services to the National Council of Educational Research and Training, State Governments and other educational authorities.

(iii) The curricular materials produced by the study groups should be co-ordinated and integrated into a model curriculum for science and mathematics by the Department of Science Education of National Council of Educational Research and Training and made available for application on a national scale.

(iv) Science and mathematics should be taught particularly at the middle and high/higher secondary school stages not as general science, but as Physics, Chemistry, Biology and Mathematics as individual subjects and at the same time, the organic relationship between these branches and the unity of science must be emphasised.

Physics Study Groups Sponsored by NCERT

Calcutta Study Group: Pursuant to these resolutions study groups have been set up by NCERT in collaboration with Universities and Institutions of higher learning to develop curricular materials in four basic branches of science, viz. Physics, Chemistry, Biology and Mathematics. In Physics, three study groups were initially established at (i) the Saha Institute of Nuclear Physics, Calcutta, (ii) the National Physical Laboratory, Delhi and (iii) the Physics Department of the University of Rajasthan, Jaipur. Two more new groups are now working at (i) Doon School, Dehra Dun and (ii) the Physics Department of the University of Nagpur. The view points of the Physics Study Group, Calcutta are presented here. The following points were taken into consideration in formulating the curriculum.

(i) Although we believe in investigative type of approach to science, under the conditions prevalent in this country, it is not possible to do away with the text-books altogether. It has therefore been decided to ignore the approach typified by Nuffield Project. The course should be meant for all types of students irrespective of their background : economic, social or intellectual.

(ii) It is also to be noted in this connection that the teachers on whom the responsibility of imparting these courses ultimately rests have also varied background and the present average level of their adaptability and ingenuity required to try out anything new is not quite satisfactory due to various reasons. The course should thus be as independent as possible of the teacher and lay more stress on the activities of the students themselves.

(iii) Formal teaching of science without corresponding development of scientific attitude will not allow us to attain the basic objective of the course. In our country, the majority of the students do not continue their school education beyond a limited stage and it is felt that the aim of any elementary science course should be to develop scientific spirit which will enable the students to tackle their problems on their own. For this reason, mere cataloguing of a mass of scientific data is not only useless, but is actually detrimental to the development of science in this country.

(iv) The course should be such as to benefit not only those students who will choose

science as their career but also provide a solid, scientific background for students undertaking non-science courses.

(v) In a scientifically and technologically oriented society, very often important decisions involving scientific and technological points have to be taken by administrators, politicians and economists The science courses should therefore be so designed that they can impart a scientific make-up of mind to help removing aversion towards science which is currently riddling our society.

(vi) In view of the points (i) and (ii), it is felt that whatever be the details of the curriculum, the Nuffield type of approach, i e. teaching a course without a textbook is absolutely impracticable under the present Indian conditions. The teaching material must be based on a textbook which should be self-explanatory for the students so that if for any reason a student is absent for a few lessons, he has an opportunity to make up the arrears by himself. It should be the aim of the course to teach physical principles by actual experiments in which students should actively participate and attempts should be made to develop experiments which should be cheap, can be fabricated even in a village smithy using locally available materials. Any material or tool described in the textbook which is not easily available, should be provided to every school in the form of a kit A teacher's guide containing detailed information about the topics in the textbook and describing the actual *modus operandi* to be followed in teaching the course to a class, should complete the basic curricular material. Supplementary readers meant to nourish, develop and strengthen the budding scientific spirit in young children following the course should also form an integral part of the curriculum.

Procedure Adopted in Writing the Teaching Material

It is estimated that on an average 90 periods, each of one and a half hour duration, will be available for the physics courses every year during the first three years of primary science education. The lessons for the model textbook prepared by the NCERT Physics Study Group, Calcutta are based on this estimate of teaching time Many of the lessons prepared have been tried in the local schools from teaching point of view and the results of these experiments have been fed back to modify the lessons accordingly. All the experiments suggested for demonstration by the teachers have been designed, fabricated and tested. Some of the teaching material developed has already been published. The syllabus for 10^+ age group boys is given in Appendix 1.

In writing the textbooks satisfying the criteria discussed above, it is necessary to adhere to certain basic working principles which will be discussed now. Firstly, direct narration should be used as far as practicable This will serve to generate within the students a feeling of self-involvement in the teaching process. In contrast to indirect narration which is impersonal and therefore more distant, direct narration immediately brings the students close to the subject matter. The importance of this simple but effective psychological trick has been recognised by many educators and psychologists. Secondly, in selecting examples and illustrations every effort should be made to take them from everyday life and environment, which is common especially for students coming from low income groups. This serves the two-

fold purpose of making the principles involved familiar in terms of experiences already gained by the students and at the same time developing logic which gradually explains the phenomena experienced by the students. Thirdly, it is absolutely necessary to avoid detailed descriptions and narrations which are not vital to the development of any fundamental physical concept. We have emphasised above that the real aim of every elementary science education programme should be the development of scientific spirit Unnecessary loading of memory of the children merely serves to generate repugnance rather than attraction towards science in all but a few exceptional cases. Fourthly, the use of every technical term should be preceded by its precise explanation. Although it is an obvious rule to be followed almost without exception in every discipline, it is also one of the most oft-violated rules resulting from the fact that the writer cannot, in all cases, identify himself with the students. Fifthly, unnecessarily complicated examples, unusual types of instruments etc. should not be used. Lastly, in developing every major new concept, attempt should be made to keep the pace of development as slow as is practicable. Wherever possible the students should be led gradually towards the concept through numerous examples and experiments. It must, of course, be acknowledged here that it may not be possible to follow the rules laid down above completely in all cases due to certain circumstances like considerations of limited amount of space and time in which the course has to be completed and so on. But as a set of general working rules guiding the development of textbooks, we think that these are adequate.

A comprehensive list of the various projects devoted to the development of curricular material in Physics and other branches of science has been compiled by J.D. Lockard.

Conclusion

The proposed syllabus has not been tried on a full scale. The model textbook prepared may thus have many loopholes. The suitability of any teaching material can only be tested by extensive field experiments. However, no textbook can be declared as final or ideal. It has to be revised periodically on the basis of experience gathered by the teachers while teaching the course. Although the text material is written in English it is proposed that the actual teaching would be done in regional languages. The students should be provided with the vernacular version of the book.

We want to record our thanks to Prof. B D. Nagchaudhuri who initiated the project and participated during the first part. Our thanks are also due to Professor D.N. Kundu, Director, Saha Institute of Nuclear Physics for providing facilities. We are also grateful to the authorities of Mitra Institution (Main), Calcutta and Jodhpur Park Boys' School, Calcutta for helping us to try out the lessons.

APPENDIX I

Model Syllabus for 10^+ Age Group Students

First Year (Age Group 10+)

Chapter I : Measurement of length; what is meant by measurement ; necessity for a

standard unit of length ; use of a scale , errors in measurement ; measurement of length along a curve ; measurement of large distances , idea of graph ; scaling

Chapter II : Measurement of area; what is meant by area; measurement of an area of a rectangular (or square) figure ; use of graph in measuring area; area of a figure other than the rectangular or square figure

Chapter III : Measurement of volume; what is meant by volume ; how does the volume of a vessel or of a regular solid depend upon its dimensions ; use of measuring jar in the measurement of volume; measurement of volume of regular and irregular solids.

Chapter IV : Time-interval and its measurement; what do you mean by time-interval; unit of time-interval; measurement of time-interval ; sun-dial ; sand clock ; water clock ; pendulum clock ; stopwatch ; small time-interval.

Chapter V : Motion ; what do you understand by motion; displacement, speed and velocity ; uniform velocity ; average velocity and instantaneous velocity; acceleration along a path

Chapter VI : Force ; what is meant by a force; the pull due to gravity; muscular pull; kinetic pull ; springs and rubber bands ; frictional force ; magnetic and electric forces.

Chapter VII : Weight and mass; what is meant by weight ; mass of a body and how does it differ from its weight ; measurement of mass; spring balance ; rubber band balance ; equal arm balance ; micro-balance ; density.

Chapter VIII : Electricity; simple experiments with a torch bulb, a cell and connecting wires of different materials ; conductors and insulators; idea of a circuit; heating effect of electric current , effect of current on magnet ; chemical effect of current.

Chapter IX : Structure of matter, what is matter, classification of matter into solids, liquids and gases; particle nature of matter; size of a molecule , what is an atom.

APPENDIX II

Portion of Physics from General Science Syllabi of Different States that were Made Available

I. ANDHRA PRADESH

Class VI

1. Air—Air pressure.
2. Water—Water supply

Class VII

1. Heat—sources of heat · fuels, effect of heat · expansion and change of state—three states of matter—change of temperature. Thermometers (Centigrade and Fahrenheit) Clinical thermometer Radiation, conduction and convection.

2. Light—its importance to plants and animals. Sources of light, working of an oil lamp and an incandescent gas lamp (Petromax), electric light. Propagation of light. Shadows (eclipses).

Class VIII

1. Force, gravity, centre of gravity, Measurement of weight, Spring balance, ordinary balance (difference between mass and weight) ; Magnets and their properties, Earth as a magnet, Mariner's compass. Frictional electricity, attraction, repulsion and induction, lightning and lightning conductors.

2. Light—refraction of light, Slab, Prism spectrum colours, Lens (convex and concave). Magnifying glass

II. ASSAM

Class VII

1. Matter and its three states.
2. Physical properties of water and air, Buoyancy and principle of Archimedes—Pressure of Atmosphere.
3. Effect of heat on water—evaporation and condensation. Effect of heat on air—ventilation. Effect of heat on solids—pendulum, clocks—compensated pendulum, thermometer.
4. Transference of heat—conduction, convection and radiation—thermoflask.
5. Energy and its transformation—mechanical energy, kinetic energy, heat energy, sound energy, light energy, magnetic energy, electrical energy, chemical energy and tidal power.

Class VIII

1. Light—rectilinear propagation of light—reflection and refraction of light, colour, spectrum, rainbow, mirage.
2. Magnetism—Load stone—artificial magnet—magnetisation—induced magnetism—bar magnet—magnetic poles—terrestrial magnetism—compass.

III. BIHAR

Class VI

1. Air—its main constituents. Natural agents for purifying air.
2. Water—water vapour in nature, fog, mist, cloud.
3. Drawing of water from wells, advantages of the pulley system.
4. Magnet.
5. The moon and the earth. Determination of time during night and day by watching stars and the sun.
6. Description of one's own image in a plane mirror and the laws of reflection, light travels in a straight line. Observation of refraction of light—appearance of a straight stick in water in different positions, observation of rainbow
7. Working of a common balance and a spring balance and their comparative uses.
8. Liquid seeks its owns level.

Class VII

1. The water supply in towns and villages.
2. Thermometers and their uses
3. The sources of heat—sun rays, fuel, chemical action and friction; measurement of heat—body temperature and clinical thermometer, how iron rims on bullock cart wheels are mounted; expansion and contraction of solids, liquids and gases by simple everyday examples.

IV. MAHARASHTRA

Class V

1. Air—existence of air; it occupies space; it has weight. Air in motion—winds and storms.
2. Water—sources of water; water cycle—a few more details regarding vapour, clouds and rain.
3. The sky—the sun, the moon, the pole star. General idea of the relative distances between the earth, the sun and the moon.

Class VI

1. Air—temperature of air, water and human body. How temperature is measured in Fahrenheit and Centigrade scales.

Pressure of air. Demonstration by common examples and experiments. Moisture in the air—how it is detected. Weather—weather signs and weather reports

2 Water—properties of water—water finds its own level. Three states of water—ice, water and steam, important characteristics of these , clouds, fog, dew and rain.

3. The sky—the moon and phases of the moon Solar system—stories about the discovery of motion of earth round the sun—Copernicus and Galileo. Relative sizes and distances of the planets.

Class VII

1 Air—putting air to work—wind mill, common pump and football inflator.

2. Water—moisture in air, effect of water vapour on climate.

3. Simple mechanics—lever and its application ; physical balance and its use , weighing by a physical balance. Indian and other weights.

4. Friction—its use and handicaps

5. Frictional electricity—simple experiments to show two kinds of electrical charges, gold leaf electroscopes, conductors and insulators.

6. Matter—three states of matter—solid, liquid and gas. General properties and their uses. Change of state.

7. The sky—the sun as a source of energy Study of three bright stars.

8. Light rays—their properties , plane mirrors.

Class VIII

1 Air—historical stories of airships and balloons. Use of hydrogen and helium How kites, aeroplanes fly? Use of aeroplanes in transport Atmospheric pressure—idea of vacuum and partial vacuum, use of vacuum cleaners. Atmosphere at different heights, on mountains and in the mines.

2. Density and its determination—specific gravity and its determination by sp. gr. bottle—sp gr. of liquids by U-tube and Hare's apparatus.

3. Natural and artificial magnets—poles and their action. Magnetisation by single touch

4 Rectilinear propagation of light, shadows and eclipses. Reflection and its laws. Formation of image by plane mirrors.

5. Two kinds of electricity and their actions. Equal but opposite production of electricity by friction.

6. Power—general idea of sources of power—sun, wind, water, oil, steam and electricity. Steam engine, water-turbine, motor car engine, electric motor—general idea of working.

7. Friction—change on the outer surface, leakage of electricity from point—lightning conductors.

8. Simple machines—pulley, wheel and axle, screw—uses in life.

9. The sky—the milky way, meteors and comets ; stories about great astronomers. Use of telescope.

10. Measurements—length, mass, time and their basic units Area of rectangle, triangle and circle Volume, use of measuring jar, burette, pipette.

V. DELHI ADMINISTRATION

Class V

1. Principal constellations in the sky. To recognise some principal constellations in the sky. The Great Bear (Saptarshi).

2. Sources and effects of heat—expansion, contraction—change of states Use of thermometers, clinical thermometer.

VI. GUJARAT

Class V

1. Senses—the eye—its comparison with a simple camera ; images and lens
2. Study of the sky—the Pole star and other stars, planets and the milky way.

Class VI

1. Water—how rain is caused Evaporation and clouds and rain.
2. Movement—muscles and how they work. Balance and the centre of gravity. How the balance is maintained while climbing up or coming down steep hills. Inclined plane ; mountain roads , levers in everyday experience. Hands and feet as levers. Levers reduce exertion. Difference between carrying things on the head, the back and by pushing or pulling.
3 Senses—why we see colour in things in light only ; effect of colours on surroundings. Protective colouration on animals, the structure of the ear. Sound—how produced Echo
4. Study of the sky—planets and planetary system. The solar and lunar eclipses.

Class VII

1. Air—cycle pump and syringes Air pressure. Air compression.
2. Movement—use of wheels—increase or decrease of speed and reduction in exertion. Water wheel ; charkha wheel ; potter's wheel and wheel of the sewing machine, etc. Chain in a cycle, gearing. Friction and lubricants.
3. Study of the sky—the solar and lunar system of the calendar, intercalary month.

Class VIII

1. Effects of reduced pressure on breathing; atmospheric pressure, its measurement; simple barometer—its construction and uses; measurement of altitude.
2. How light travels; pin-hole camera; rectilinear propagation of light; principles of reflection, multiple image and mirror inclined at 90° and 72°; kaleidoscope; simple mirror periscope.
3. How heat travels, conduction, convection, radiation; everyday application of the principles of transference, thermoflask; Davy's safety lamp; polished surfaces, expansion of solids, liquids and gases when heated, practical applications.
4. Magnet as an aid to navigation; fixing directions; natural and artificial magnets; lines of force; magnetic poles; laws of attraction and repulsion.

VII. KERALA

Class V

1. Water and air pressure—buoyancy, upward thrust. Water finds its level: pressure in two limbs of a U-tube, town water supply. Air pressure; ink rises in ink filler, measurement of air pressure—barometer.
2. Heavy bodies—the solar system; recognition of Venus; stars and constellations; Pole star, the Great Bear, the southern cross; planets and stars; stars are luminous and twinkling; planets do not twinkle.

Class VI

1. Heat—expansion of solids due to heat; expansion of liquids due to heat—thermometers; expansion of gases due to heat, change of state, conduction; convection ; radiation; the thermoflask.

Class VII

1. Light—light travels in straight lines; shadow; pin-hole camera. Images in a plane mirror, lateral inversion. Convex lens as magnifying glass, instruments using lenses mentioning camera, eye, microscope, telescope, projector, binoculars. Rainbow, dispersion of light through a prism, story of Newton.

2. Magnetism and electricity—attraction of iron filings; poles of a magnet; repulsion and attraction between magnetic poles, directive properties of magnets, magnetic needles, mariner's compass.

The dry cell—lightning effect of electricity, story of Edison.

Heating effect of an electric current—electric heaters.

Magnetic effect of electric currents—electromagnet; electric bell.

Magnets producing electric current—movement of a magnet near a copper wire; movement of a coil carrying current between two poles of a magnet. Principle of the dynamo. Use of engine or water power.

VIII. MADHYA PRADESH

Class VI

1. Three states of water. Use of steam—investigation of James Watt, railway engine.

2. Heat—sources of heat, methods of producing heat. Effect of heat. Expansion due to heat— in solids, liquids and gases. Practical application of various effects due to heat. Conductors and insulators.

3. Machine—railway train, motor car, telegraph, telephone, ships, submarine, balloon and airship.

4. Matter—measurement of length. Measurement of area, rectangle, circle use of the graph paper.

Class VII

1. Heat — temperature. Thermometer—clinical, maximum and minimum thermometer. Freezing point and boiling point, difference between the two, melting of wax, boiling point of water, effect of impurities on the boiling point of water, effect of pressure on boiling point. Transmission of heat—conduction, convection and radiation, thermoflask.

2. Matter—states of matter, volume, units of volume, measuring volume of regular and irregular solids; mass and weight—gravity, spring balance, unit of measurement

Principles of lever—three kinds, balance. Density, units, measurement of density of solids.

Class VIII

1. Air—air pressure, barometer, its uses, instruments working on the pressure of air—syringe, exhaust pump, oil pump, force pump, cycle pump, stove, siphon, Vasudev cup.

2. Heat—conversion of temperature from one scale to another.

3. Energy and electricity—electricity by friction—positive and negative electricity, conductors and insulators, atmospheric electricity, experiment of Benjamin Franklin, lightning and protection from lightning. Current electricity—introduction, voltaic cell, dry cell, battery. Flow of electric current, electric lamp, torch, heater, bell, electroplating.

4. Matter—pressure due to liquids, upward thrust, downward thrust. City water supply, fountains. Up thrust in liquids—stories of Archimedes, principle of Archimedes Relative density, lactometer, submarine.

IX. TAMIL NADU

Class VI

1. Three states of matter—solid, liquid and gas.

2. Light—its relation to life and seeing, chief sources of light—the sun and stars.

Class VII

1. Expansion of bodies when heated—temperature, thermometer. The Doctor's thermometer.

2. Water finds its level. The water level and spirit level.

3. Water falls—water wheels (windmills—lift pumps).

4. The wheel and axle.

5. The steam engine—its working (an elementary treatment).

Class VIII

1. Sun, a star; sun spots, meteors and comets.

2. Methods of transmission of heat—Conduction, convection and radiation. Water and air currents. The thermoflask.

3. Eye and its functions —long sight and short sight. The uses of spectacles.

4. Sun—source of energy, locked up by green plants and released during respiration.

5. Force of gravity—centre of gravity and conditions of equilibrium (stable, unstable and neutral).

6. The ears and hearing.

7. Sound—how produced and transmitted; echoes; musical instruments (string, wind and percussion) and the quality of sound they produce. The vocal chords.

8. The Radio—the elementary knowledge of what it is and how it works.

X. MYSORE

Class V

1. Simple machines—lever, pulley, inclined plane, wheel and axle (gear). Friction and use of lubricants.

2. Transportation—discovery of wheeled carriages.

3. Different kinds of power used—animals, steam, petrol, electricity

Class VI

1. Sources of light—sun, oil, electricity.

2. Transportation—by land, road and rail. Locomotive by Stevenson. By sea—boat, sail ship and steam-ship. By air—aeroplane, work of Wright brothers.

3. Compound machines—bicycle, sewing machines.

Class VII

1. Air—properties of air, air has pressure, air is compressible.

2. Sources of heat—wood, charcoal, coal, oil and electricity.

3. Effects of heat—expansion, change of states, change of temeperature, three states of matter.

4. Thermometer— centigrade, Fahrenheit and clinical

5. Communication—post, telegram, telephone, radio, work of Marconi.

6. Power driven machines — buller, tractor.

7. Eye—its main parts. Defects of eye sight—proper care of the eye.

8. Ear— its main parts—proper care of the ear.

XI. ORISSA

Class VIII

1. Measurement of length, area, volume and mass. Three states of matter. Archimedes principle, floating of ships, airship and balloons.

XII. RAJASTHAN

Class V

1 How dew, fog, snow and clouds are formed and seen; what is the difference between mist and fog; rainbow.

2. Three states of matter—solid, liquid and gas.

Class VI

1. Properties of matter—nature. To measure length. Use of calipers. To determine the volume of straight and plain bodies. Measuring glass. Use of burette and pipette. Gravitation. Difference between mass and weight. Physical and spring balance, rough balance, lever's principle. Simple machine, for example—lever, pulley and screw. Density.

2. Heat—a kind of energy. Different causes of production of heat, for example—sun, fire, rubbing.

Effect of heat on solid, liquid and gas. Change in state by heat. Centigrade, Fahrenheit and clinical thermometer.

3. Solar system—the story of birth of the earth.

Class VII

General properties of matter. Specific gravity and Archimedes principle. Its application on floating and sinking bodies. Principle of floating, hydrometer, lactometer, balloon, submarine.

Water finds its own level. Pressure of gas and liquid and illustration by simple experiments. Measurement of height with the help of barometer and its experiment to know the weather. Siphon, Vasudev cup. Pump—water pump, kerosene oil pump, cycle pump, foot ball pump, clinical spray, fountain pen, stove (kerosene oil).

Heat—production of temperature in the room according to necessity How heat flows ? How the mattresses of khus and jwas remain cold. Production of light by heat. Conduction, convection, radiation and their application.

Blowing of air by heat. Ventilator.

Light—a kind of energy. Characteristics of light. To form image by pin-hole camera. Shadow, solar amd lunar eclipses, reflection.

Class VIII

Heat, steam and its energy. Simple introduction of steam engine.

Light—refraction of light and uses in nature, sun. Spectrum or illustrations of seven colours. Rainbow.

Sound—production of sound. How we hear sound. Simple idea of gramophone.

Electricity and magnet—characteristics of magnet, natural and artificial magnets, compass. Its uses on water and earth. Two kinds of electricity—electrostatic and current. Thundering of cloud and lightning, why and how? How the buildings are protected by lightning conductor. Dry cells and torch. Heat, light from electricity and magnetic effects of current. Simple uses of electricity and electric bulb in the house. Construction and working of electric bell, iron heater etc.

General idea about radio and X-ray. Simple ideas about molecule, atom, electron, proton, etc.

XIII. TRIPURA

Class V

1. Night sky—Nebula, milky way, comet, meteor, the Great Bear and Pole star—short discussion about them. To determine direction with the help of Pole star.
2. Weight. Mention gravity and weight through Newton and apple story (Students will take weight of few bodies with a spring balance).

XIV. UTTAR PRADESH

Class VI

Levers of class two and three, for example, wheel barrow, nut cracker, mango squeezer, tongs, etc.

Measurement of volume and capacity. Volume of solid and liquid. Different apparatus for the measurement of volume. Simple lactometer. Centre of gravity, weight and mass. Spring balance. Principle of balance. Physical balance.

Heat—its sources. Effects of heat on solid, liquid and gas. Thermometer—centigrade, Fahrenheit. Clinical thermometer and minimum and maximum thermometer. Effects of impurities on boiling and melting points of general substances.

Magnet—natural and artificial magnet. General properties of magnet. Methods of construction of artificial magnets.

General properties of matter—state, colour, odour, taste, density. Effects of heat.

Class VII

Fixed and movable pulley. The uses of system of pulleys (Mathematical calculation is not necessary).

Pressure of air—simple barometer.

Density of solid and liquid.

Transmission of heat—conduction, convection, radiation. The experiment of the principle of the transmission of heat in daily life. Davy's safety lamp. Thermoflask and ice box. Frictional electricity—conductor and insulator, lightning conductor.

Class VIII

The uses of the principle of the following apparatus in daily life—wheel and axle, inclined plane, nail and screw (calculation is not necessary). Working method of simple pump. Lift pump, bicycle and football pump and siphon

Pressure of liquids, Archimedes principle, application of the principle on floating and sinking submarine. Working method of balloon and submarine. Lactometer.

Relative density. Application of bottle in relative density. Application of Archimedes principle for finding the relative density of a few substances. Simple calculation on the basis of the above principle.

Light—source. Straight line propagation of light. Pin-hole camera. Eclipses. Reflection of light. Kaleidoscope To show the laws of refraction.

Electric current—simple and dry cell. Heating, lighting and magnetic effects of current. Electric wiring in the building. Fuse, electric apparatus—heater, iron, bulb and bell.

Solar system. Planets, satellites, comets, shooting stars and their feature.

XV. WEST BENGAL

Class VI

Atmosphere, air, water vapour, clouds, wind, storm, thunder and lightning, rain, hail, snow, dew, fog, mist ; monsoon, air becomes cooler higher up in the hills (snow on mountain tops), in aeroplanes,

air becomes less dense higher up ; difficulty in breathing on mountains (These topics should be treated mainly in a descriptive manner).

Water—wells and tube-wells ; all objects are attracted by the earth ; deduction from the common experience of falling bodies.

Heavenly bodies ; simple idea of solar system—the sun, the planets, the satellites especially the moon. Difference between planets and stars Sun is a source of heat and light, radiation of heat in different seasons.

Class VII

Air has weight ; air pressure and breathing. Main principles involved in ventilation ; how air rises and cool air sinks ; methods of ventilating a room and a kitchen. Air develops force, does work—kite, sail.

Water—evaporation, condensation, rain cycle, solidification.

Class VIII

Pressure of air—existence of air pressure by demonstration.

Torricelli's discovery that an ordinary pump does not work if the level of the water in the well drops below 34 feet. The mercury barometer (simple type), its readings at different altitudes. The barometer and weather forecasting. Syringe, siphon and flush tank. Suction pump or air pump, compression pump (football pump), the primus stove.

Pressure of water—pressure of liquids, balancing columns of water, lockgates, water finds its own level, town water supply, artesian wells ; transmission of liquid pressure in different directions ; water wheel, water dam ; Archimedes principle—upthrust in water, floating bodies, iron vessels float ; submarine ; density of solids and liquids.

Magnetism—natural and artificial magnets, magnetic induction, magnetic poles. The earth as a magnet, magnetic compass for navigator and surveyor.

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New Biology : A Point to Ponder

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MAN is a unique biological being. He is a product of two heredities, one, biological and the other, sociocultural. The sociocultural element, to a modern man, is as much a part of his nature (cultural heritage) as it forms his nurture (environment). It has both individual as well as collective implications. The youngest innovation in man's cultural heritage, science, has not only the strongest impact on intellectual pursuits of man, but it also has the deepest influence on his day-to-day life and thought. Science has been acting as a powerful agency to transform the intellectual fabric of the people and society.

Science, as an exclusive branch of knowledge, has evolved with an ever increasing velocity. Its development, specially during the recent times, is simply amazing. The population of working scientists today far outnumbers the total number of scientists ever lived in the past. The number of scientists, output of research papers and financial investment on research indicate that the doubling period for science is about ten to fifteen years, maintained since the scientific revolution in the western world.

Science training has spread its root deep into every society. In India also the rate of growth of science training and research has been accelerated considerably since the advent of national planning

Science, unlike any other branch of human pursuit, is not only a body of knowledge but also the method of acquiring it. Methodology and achievements are inseparable. The progress of one accompanies the other. The explosive growth of science in a short space of time has revolutionised the entire psychosocial composition of human beings and, paradoxically, of science itself. The cumulative effect in quantitative terms has, in its stride, transformed it qualitatively.

The development of Biology is no less, and practically far more spectacular. Biology is far away from the subject which our grandfathers, fathers or even ourselves learnt It is no more a sort of philately; biological phenomena are almost explicable in physical terms. Unfortunately, the progress of Biology and its teaching in India, is lagging far behind the contemporary scene. We can ill-afford to sit idle over modernizing Biology and its teaching, catering to the need and aspirations of the country. Our children must keep pace with the tremendous widening of the content and attitude of modern Biology. Hardly do we require any more Committee, Conference or Commission simply to convince the need of modernizing education in Biology. The energy and

thought should be focussed, instead, to find ways and means of the actual operation and deciding upon the steps and priorities of implementation. In the impending task of modernization, the approach and content should be carefully weighed in terms of the actual need, condition and competence of our society.

Education is the means of transmission of the sociocultural heredity. It consists of the core of culture which a generation purposely gives to the next in order to qualify them for keeping up, and, if possible, for raising the level of improvement that has been attained So, structure of education differs with time and place. Its aim and implementation are bound to be different in urban areas, rural surroundings as also according to stage and tradition of the social set-up. Countries, even with many affinities and cultural bonds, tend to differ considerably in the theory and practice of their education.

It is often said that science has no boundary ; unfortunately, in the world of to-day every thing has. Even if the universality of science is accepted which only a robust optimist would dare surmise, the practical implementation of any science education is definitely limited by national capabilities. Development of science teaching (including Biology) is dependent upon the socio-economic and intellectual infrastructure. For under-developed countries, financial stringency always stands in the way of providing minimal laboratory and library facilities. The dearth of competent teachers and lack of proper teachers training facilities would always tend to cut down any gigantic ambition. Conservatism of the teaching community, specially, in a stagnant and traditional country, as India is, would always be a limiting factor of formidable effect.

Determination of the aim and form of new Biology at various stages in the national context is another tricky task. India is a vast country with divergent socio-economic and cultural niches. There are innumerable diversities in the pride and prejudice of the people depending upon the cast and creed, region and religion, language and occupation. And there is always the strong back-push of a huge illiterate population, the dead weight amounting to more than 350 million. The need and natural curiosity of a highly urbanised up-coming student of a metropolis like Calcutta, Bombay, Delhi or Madras is bound to be qualitatively different from those belonging to a village of Himachal Pradesh with its agrarian background. As regards intellectual appetite, a slum dwelling emaciated kid is planets apart from his more fortunate neighbour. We will also have to find out a golden mean between the conflicting purposes of education : whether the young should be trained at such studies which are useful to him for his livelihood or in that which tend to promote his intellectual virtues and higher studies.

So far I have raised only problems, and only a few at that. I do not venture to propose any ready solution. I am afraid, no single mortal can or would even venture to prescribe any easy recipe. But we must collectively rise boldly to the occasion and try to find out the answer.

Traditional Biology is already an established discipline in the sphere of higher education. Modernization is likely to be comparatively easy in this area. The courses, for the present, should be as much diversified as possible. We should not develop any rigid fad or impose a subject of our liking or any dogma be that Biophy-

sics, Biochemistry or Biometry, in the name of modernization.

Framing of a modern curriculum is not merely putting down of the content of a recently published foreign book, as has sometimes been practised. A modern curriculum is a thought-consuming process which demands a good deal of knowledge of the applicability of a formula, its feasibility both social and fiscal, and above all, a judicious use of available resources. Widest possible choice of specialization should be given to the student ranging from Animal Behaviour to Exobiology. The main criteria of modernization would be to provide students with an opportunity to have the glimpses of the frontiers of his field of study from the closest range. They should be imparted proper training for breaking new grounds with most modern methods and techniques. The centres of higher studies should evolve their own fields of specialization depending on the geographical location, natural scope and facilities of flora and fauna as well as available intellectual expertise.

Education Commission has recommended the inclusion of Biology in the school curricula. It is high time when we should start and that on our own, with right earnest to impart the teaching of new Biology at the school level. No education is an importable commodity The nature and form, the content and method would naturally depend on the hard facts of reality. A Commission, at the national level, consisting of competent biologists, should go into the problem of formulating the broad outlines of the courses of new Biology. The content should reflect a modern comprehensive attitude, incorporating a dual outlook. It should be somewhat complete in itself and at the same time should be stimulating for higher studies. The young mind is more curious about his close surroundings and is prone to concern himself with his immediate problems. The training should help to satisfy his basic curiosities and imbibe in him the spirit of facing bigger problems. His biological training should concern his own life. A child is more interested in doing things than in abstract theories. He is inherently more inductive than deductive. So the curricula, unlike the existing trend, should include more of practicals, field works, excursions and activities. This point can hardly be overemphasised. Systematic efforts should be directed to infuse the basic scientific attitude, disciplined and unbiased, into his adventurous natural inclinations.

The formulations on the national basis should be broad based enough to enable the manoeuvring of the class teacher and keep room for the expression of his individual talent. Large number of alternative possibilities should be thought out to meet the requirements of different cultural niches and social backgrounds. Active participation of working teachers, who are at the grassroot of execution, should be obtained in framing the blueprint of implementation.

To sum up, all my submissions are in favour of diversity and variation reflecting the social topography of India and against intellectual regimentation and massive uniformity in any form. Let Biology of tomorrow bloom harmoniously with varying hues and fragrance.

Study of Surface, Part V : Ultra-high Vacuum

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Introduction

IN my earlier article (*School Science*, Sept. 1970), I have pointed out how soon after generation, a surface gets contaminated, i.e. becomes dirty in the common usage Even under a vacuum of the order of 10^{-6} torr, it takes only a few seconds for the surface to be covered by many layers of chemical dirt, i.e. adsorbed species. It is only under a vacuum of the order of 10^{-8} or 10^{-10} torr, that a surface can be kept clean for a few hours for any definite study to be made which may be a chemical reaction, or electron emission of super-conductivity of the sample.

In the same article, I have also discussed the ways of creating and measuring moderate high vacuum, i.e. up to 10^{-6} torr. In order to create and measure ultra-high vacuum (10^{-9} or less) one has to make use of special techniques. In this article, I would like to discuss some of them.

Pumps for Ultra-high Vacuum

Pumps commonly used to produce ultra-high vacuum fall into four main categories.

(1) Diffusion pumps.
(2) Ionization pumps.
(3) Chemisorption pumps.
(4) Cryogenic pumps.

Out of these, diffusion and cryogenic pumps have been most commonly used for studying high vacuum system for the last few decades.

Diffusion Pumps

Diffusion pumps function by entrapping gas molecules in a fast moving vapour stream. Such pumps do not require moving mechanical parts. Langmuir, father of surface chemistry, modified the earlier jet-ejector pumps to produce condensation pumps using mercury or low vapour pressure oils as the working liquids. The figure on next page shows a three-stage mercury diffusion pump

The choice of a diffusion pump for any particular system is controlled by two requirements.

(1) Adequate pumping speed.
(2) Minimum rate of back-streaming of the pump fluid. Mercury diffusion pumps have three principal advantages for ultra-high vacuum use.

i) the pump fluid is very easily trapped at liquid nitrogen temperature.
ii) it can operate against a high backing pressure, so that the backing pump can be turned off for long periods.
iii) the fluid is thermally stable.

Mercury diffusion pumps are preferred over oil diffusion pumps whenever it is essential to avoid contamination from hydrocarbon vapours,

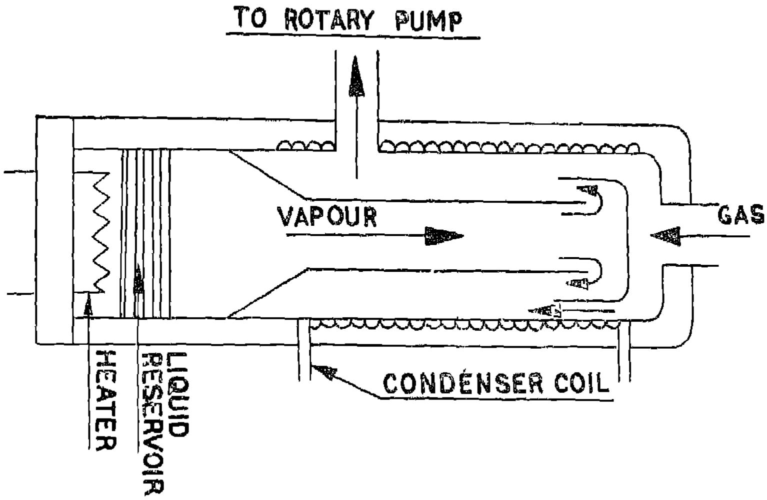

Fig. 1. *Diffusion Pump.*

Oil diffusion pumps are more widely used than mercury pumps because of the following reasons :

(i) Pump fluid is less dangerous.

(ii) The recently developed traps for oil vapours do not require refrigeration.

Polyphenyl ethers have been found to be very efficient pump fluids.

The pumping speed of a diffusion pump is limited by the efficiency of entrapping the gas molecules from the system by the vapours of the pump fluid. A rule of the thumb is that pumping speed in litres/sec. is approximately equal to $2d^2$ where d is the internal diameter in centimetres of the intake tube.

The ultimate capacity of a mercury diffusion pump is limited primarily by the back diffusion of vapours from the backing or rotary pump, connected to the diffusion pump. However, proper substitution of cold traps prevents this back streaming and helps in the attainment of ultra-high vacuum. Using liquid nitrogen traps, pressures of the order of 10^{-12} torr have been achieved.

Getterion Pumping

In the phenomenon of gettering, a chemically active metal is evaporated in the presence of a residual gas. The gases which react with the metal are said to be gettered by the evaporated film. The gettering of chemically active gases is greatly enhanced when they are excited or dissociated by a gas discharge. Molecular nitrogen, for example, is not adsorbed on Ni even at temperatures up to 1000° C, but if it is dissociated into atoms, the atomic nitrogen is adsorbed readily at room temperature. This aspect becomes quite clear when one compares the potential energy diagram for the two cases.

Getter pumps have advantage over diffusion pumps on account of their suitable design But they suffer from the disadvantage that their pumping speed for inert gases is considerably lower than those of diffusion

pumps. Moreover, only a limited number of getter materials have been used and all of them are pure metals (Ti, Zr, Ta, Mo, W).

Cryogenic Pumping

Physical adsorption and/or condensation has two main applications in an U.H.V. system—traps and pumps. A use of three liquid nitrogen traps in series with a mercury diffusion pump can give vacuum of the order of 10^{-12} torr in a small glass system.

Cryogenic pumping is the term applied to the process in which molecules are removed from the gas phase by condensation on a cold surface. It may be used in place of a backing rotary pump to produce a high vacuum. In general, activated charcoal or zeolite cooled by liquid nitrogen will reduce the pressure in a small system to about 10^{-2} torr. Cooled activated charcoal adsorbs 10 times its own volume of air. For the production of higher vacuum, liquid hydrogen or liquid helium are necessary as cryogenic liquids. The non-condensable gases must be removed by ion or diffusion pumping. Vapour pressures of some common gases at low temperatures are shown in Fig 2.

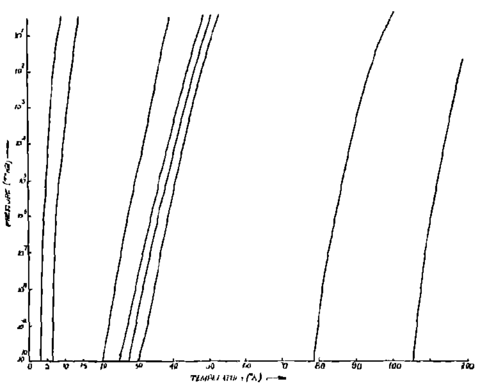

Fig. 2. *Vapour Pressure of Common Gases at Low Temperatures.*

The rate of removal of gas molecules depends on the sticking coefficient of the gas on the cold substrate and on the cold surface area available. It has been observed that condensation of molecular hydrogen was strongly dependent on the simultaneous condensation of water vapour on the target, probably the former is trapped by the latter.

The modern sealed-off electronic tubes depend on the presence of a gettering material for the maintenance of low pressure inside the tube. Table I on next page classifying metals and non-metals to adsorb gases at room temperature helps in predicting which metal will be a getter for a specific gas. At room temperature and above, no known getter adsorbs inert gases in the absence of a gas discharge.

In order to have an efficiently designed cryogenic pump, it is necessary to have a large conductance to the cold surface and to shield the cold surface of radiation from warm surfaces. For this reason, liquid helium traps are usually jacketed with liquid N_2 cooled surfaces. For these purposes special dewars have been designed.

Gauges for Ultra-high Vacuum Measurement

The devices commonly used to measure pressures in the ultra-high vacuum range are ionization gauges for total pressure and mass spectrometers for partial pressures. There are certain pre-requisites for these gauges.

(1) They must be bakeable, i.e. made of materials which can be heated at least up to 500°C without getting softened.

(2) They must not serve as source of gas.

(3) They must possess extreme sensitivity.

TABLE I

Classification of Metals and Semi-metals Based on Adsorption Properties

Group	Metals	O_2	C_2H_2	C_2H_4	CO	H_2	CO_2	N_2
A	Ca, Sr, Ba, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Fe, (Re)	A	A	A	A	A	A	A
B_1	Ni, (Co)	A	A	A	A	A	A	NA
B_2	Rh, Pd, Pt, (Ir)	A	A	A	A	A	NA	NA
C	Al, Mn, Cu, Au	A	A	A	A	NA	NA	NA
D	K	A	A	NA	NA	NA	NA	NA
E	Mg, Ag, Zn, Cd, In, Si, Ge, Sn, Pb, As, Sb, Bi	A	NA	NA	NA	NA	NA	NA
F	Se, Te	NA	NA	NA	NA	NA	NA	NA

Note : 'A' indicates adsorption, 'NA' no adsorption.

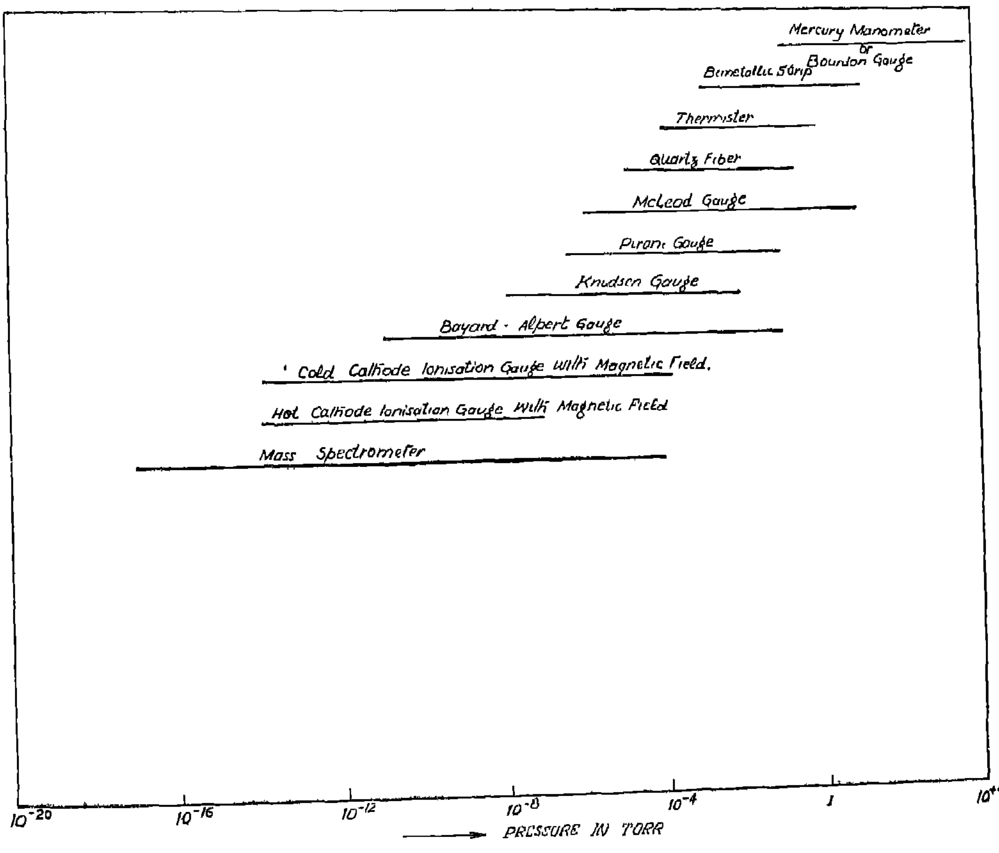

Fig. 3. *Useful Ranges of Vacuum Gauges.*

For these reasons, special considerations must be given to their construction, caliberation and operation. Fig. 3 gives the useful ranges of various vacuum gauges.

Ionic-Gauge

It should be noted that the out put from an ionization gauge is proportional to the gas density within the ionizing region. Conversion of the on gauge reading to pressure requires a knowledge of the gas temperature

Pumping Effects in Ionization Gauges

All ionization gauges behave as pumps to some extent, the removal of gas from the volume is caused by four processes.

(i) *Ionic Pumping*: The entrapment of ions that impunge on any solid surface.

(ii) *Chemical Pumping* : The removal of neutrals by chemisorption on the electrodes or the bulbs

(iii) *Activated Chemical Pumping*: The removal of excited or dissociated molecules by chemisorption. Excitation or dissociation is caused by the electron in the discharge.

(iv) *Pumping at an Incandescent Filament*. In the case of hot-filament ionization gauges, an additional pumping process is produced by dissociation of gas molecules at the hot filament and reaction with impurities in the filament. The dissociated fragments may then be chemisorbed readily at any solid surface.

Hot-cathode Ionization Gauge

In a gas at low pressures (10^4 torr), the number of positive ions produced by the passage of a stream of electrons is linearly proportional to the density of gas molecules. At high pressures, the number of ions produced is sufficient to alter the current and energy of the electron stream, and the linear relationship between ionization and gas density no longer holds due to space charge effects. Thus below 10^4 torr, a measurement of ion current serves as a measure of the pressure in the system at a given temperature.

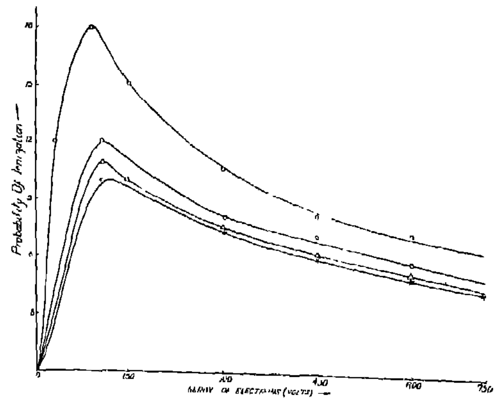

Fig. 4. *Probability of Ionization as a Function of Electron Energy.*

The number of ionizing collisions made by an electron passing through a gas at low pressures depends on the nature of the gas and the kinetic energy of electrons. The above figure (Fig 4) gives the probability of ionization as a function of electron energy It is clear that the efficiency of the ionizing process for most gases has a maximum at 100-150 volts

Thermal-conductivity Gauges

At pressures below 1 mm Hg, the heat loss from a wire to the gas which surrounds it, is linearly proportional to the pressure of the gas. This process depends on the thermal accommodation coefficient of the gas on the sensing material and the nature of the wire surface. Above 1 mm Hg,

the thermal conductivity of the gas is almost constant. Three types of devices which use this phenomenon to indicate pressure are:

1) the Pirani gauge
2) the thermocouple gauge
3) the thermistor gauge.

All these can measure the pressure of condensable as well as non-condensable gases, but must be calibrated before use.

The basic elements of a Pirani gauge are shown below:

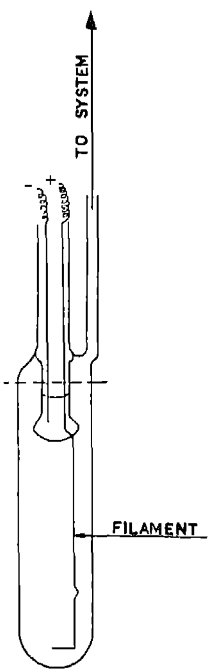

Fig. 5. *Pirani Gauge.*

The pressure-sensing element is a fine wire located in the vacuum system which forms one arm of a Wheatstone bridge. An identical wire sealed in a highly evacuated bulb forms another arm of the bridge. By using this compensator, the effects of changes of room temperature, supply voltage and ageing of the wire are avoided. In normal use, the voltage across the bridge is kept constant and off balance of the bridge because of changes in the temperature of the indicator wire on account of changes in pressure of the system are observed.

The other two devices are also run on the same principle.

Sensitivity of Gauges

The accurate calibration of ionization gauges is a difficult problem, particularly when chemically active gases are involved. The only satisfactory standard is the McLeod gauge, which is useful only up to 10^{-5} torr. For lower pressures, ion-current vs pressure relationship must be established by indirect methods.

Detection of Leaks

Those who work with vacuum system must have spent many uncomfortable hours simply finding out where the leak is. It is just like locating a discontinuity on a printed circuit.

For ordinary vacuum, soap solutions or a Tesla Coil is used. A cleavage in the column of the discharge indicates a leak. For ascertaining the exact spot, various sections of the system should be isolated one by one. The most sensitive method of measuring small leak rates is to accumulate the gas that has leaked in and then measure the pressure of the accumulated gas. In a system using ionization pumps, the leak rate for inert gases can be easily obtained by switching off the ionization pumps or gauges, when the pumping speed for inert gases becomes zero. The inert gas is allowed to accumulate for a known time and then an ionization gauge is turned on momentarily to measure the pressure.

In some cases, the gas can be accumulated into a cold surface (physisorption) or into a metal surface (chemisorption) at room temperature. The gas is later released by suddenly heating the adsorbing surface. By this method, leaks of the order of 10^3 molecules/second have been detected.

Mass Spectrometers

Mass spectrometer is the most sensitive leak detector currently known. To detect leaks,

the inlet to the mass spectrometer is connected to the system under test Helium is sprayed externally to the system. Due to its low mass, helium has a high rate of diffusion through the leaks. The intensity of the current recorded in the mass spectrometer is a measure of the size of the leak

Acetone or some suitable organic solvent, when applied to a small leak in an ultra high vacuum system will give a rise in pressure in an ionization gauge compared to a drop in pressure produced when helium is used as a detector.

Application of Ultra-high Vacuum

I. Surface Physics and Chemistry

A. In the study of adsorption of gases on metals it is necessary that the metals are cleaned properly and maintained free of adsorption. It has already been pointed out that in order to keep a surface clean for an hour or so, we require a vacuum of the order of 10^{-9} torr. Table II gives some important parameters governing surface effects.

TABLE II

Some Important Parameters Governing Surface Effects

Pressure (mm Hg)	Molecular density in gas phase (Molecule/cc)	Impingement rate (Molecules/cm^2 Sec.)	Monolayer	Ratio of adsorbed to free Molecules
1	3.3×10^{16}	3.8×10^{20}	1.3×10^{-6}	7.5×10^{-8}
10^{-6}	3.3×10^{10}	3.8×10^{14}	1.3 Sec.	7.5×10^{3}
10^{-11}	3.3×10^{5}	3.8×10^{9}	36 hrs.	7.5×10^{8}

Thus we see that in the U.H V. range, desorption of only a minute fraction of the absorbed gas will have a profound effect on the pressure in the system.

B. In order to obtain stable field emission, entry of helium into the field emission tube must be avoided as it causes sputtering of the field emitting tip and thus an increase in its radium. This has been achieved by using corning 1720 glass, which has very low rate of permeation of helium and enables a vacuum of the order of 10^{-14} torr to be maintained.

C. While depositing thin films, the presence of active gases can

(i) affect the nucleation density, mobility and adhesion of the depositing atom on the substrate;

(ii) create a high density of imperfections within the film;

(iii) influence the electric and magnetic properties of the deposited film.

In view of the large scale use of thin films in electronic component production, ultra-high vacuum techniques will be of great importance

II. Thermonuclear and Plasma Devices

In the operation of controlled thermonuclear devices, impurities affect the attainment of the required plasma temperature. The impurities in the plasma increase the rate at which energy is radiated from the plasma. Therefore, it is necessary to achieve U.H.V. before the introduction of plasma gas (usually deutrium or tritium) and also to minimise the contamination of the plasma from the walls of the chamber.

Construction of the space chambers is a difficult job, not only because of their large size but also because of the large number of observation ports, doors and other openings that must be provided in the walls of the chamber. In addition, there is the mechanical motion, vibration, high radiant influx etc.

III. Space Simulation

Before subjecting them to actual flight, it is necessary to test the space vehicles and their components under condition prevailing in the space. The following table gives the atmospheric pressure in mm Hg. as a function of the height. One can see that pressure reduces to 10^{-8} torr even at a height of about 300 k.m.

TABLE III

Atmospheric Pressure as a Function of Altitude

Height (Thousand feet)	*Pressure* (mm Hg)
0	760
30 (Mount Everest)	230
100 (20 miles)	8.5
200 (40 miles)	0.25
500 (100 miles)	1.5×10^{-6}
1000 (200 miles)	1.2×10^{-8}
1500 (300 miles)	1×10^{-9}
2000 (400 miles)	2×10^{-10}

It has been generally observed that molecules emitted from a vehicle in space rarely return to the vehicle. If this condition is to be simulated in the laboratory the walls surrounding the vehicle should have a sticking coefficient approaching unity which can be achieved by maintaining the wall at liquid hydrogen temperature.

Dr. Vikram Ambalal Sarabhai

B. SHARAN
Department of Science Education, NCERT, New Delhi

Lives of great men all remind us We can make our lives sublime And departing leave behind us Foot-prints on the sand of time.

H. W. LONGFELLOW

ON the fateful December 30, 1971, at 6.30 a m , a waiter of Kovalam Palace, a Government Tourist Hotel, knocked on the door of a suite for serving coffee to the inmate and he found to his dismay no response. The saheb who used to get up before the waiter with the coffee came to his room was still asleep. The door of the suite was broken open and a team of doctors examined and declared Dr. Vikram Ambalal Sarabhai, Chairman of the Atomic Energy Commission and The Indian Space Research Organisation, popularly known as Sarabhai as dead No foul play was suspected and death was probably due to heart failure around 2 a.m. The news like a tidal wave swept across the entire country within a matter of hours. The mother lost her dear son; Mallika 21, her father, before seeing her in a film career of his dreams, Kartikeya 25, his daddy before completing his education in USA, the Cricket Club of India, Wellingdon Sport (Bombay) and Ahmedabad Gymkhana, a sports enthusiast and the nation a great educationist and architect of space technology. The last words 'Okay go ahead' are now a matter of past as they were spoken to Shri A.R. Thakur, Assistant Director of Physical Research Laboratory, Ahmedabad and B. Ramakrishna Rao, Head of Electronics, a few minutes before 12 midnight on December 29, 1971 in connection with discussion on a space programme.

Dr. Vikram Ambalal Sarabhai was born on August 12, 1919 in the well-known Sarabhai family of industrialists in Ahmedabad. He received his higher education in the Universities of Bombay and Cambridge. Coming events cast their shadows before. Shri Sarabhai passed tripos, a rare distinction from Cambridge, in 1939 and soon after proceeded for research at the Indian Institute of Science, Bangalore. At the latter place he worked on cosmic rays from 1939 to 1945 under the leadership of the great Indian scientist and Nobel Laureate, Professor C.V. Raman, and is said to have developed the geiger counter technique for the detection of cosmic rays. The cosmic rays are of extraterrestrial origin as indicated by the discharge of a charged gold leaf electroscope. Their nature, distribution in space and origin is one of the most interesting problems.

In 1945, Shri Sarabhai joined the Cavendish Laboratory to conduct research on photo-fission and was awarded the degree of Ph D. for work on nuclear physics in 1947. Photo-fission is a process of breaking up of atomic nucleus into two parts under ray irradiation, a very important nuclear process in all

atomic explosions. This led him to become Professor of Cosmic Ray Physics, and later in June, 1965, Director of Physical Research Laboratory, Ahmedabad.

Dr. Sarabhai succeeded Dr. Homi J. Bhabha FRS, as Chairman of the Atomic Energy Commission in May, 1966, a post which he adorned till his last breath. Strangely there is a close parallel in their death. Both died young in the wake of an Indo-Pakistan war and after hinting at the probable date of producing an atom bomb. In less than a fortnight after Tashkent agreement Bhabha, then 57, lost his life in a plane crash, and now Sarabhai too apparently from heart attack at even a younger age of 52. Both were survived by their mothers, a strange coincidence of events. They only differed in attainments : Homi Bhabha put India on the world's nuclear map, Sarabhai put it on the world's space map.

The most befitting tribute that we can pay is by reminding the nation of the life and the contributions of the departed personage.

Dr. Sarabhai was a symbol of simplicity. He wore Khadi bushshirts and hand spun chappals, a tradition which he inherited from his parents who were close associates of Gandhiji.

Dr. Sarabhai was endowed with indefatigable energy, passionate devotion and a rare combination of administrative and scientific ability. Interest in music, photography and documentary film making added further to his competency.

On the administrative side Dr. Sarabhai first occupied the Chair as part-time Honorary Director of the Ahmedabad Textile Industry's Research Association (ATIRA) from 1957-65 and Indian Institute of Management, Ahmedabad.

As incharge he organised the ATIRA from its inception till the appointment of a full-time Director in 1965. He visited Japan in 1956 as a leader of productivity delegates.

As Honorary Director of the Indian Institute of Management he took a leading part in its building and establishment so that professional managers could increasingly assume the responsibility of running our industries.

On the science side, his major interests were astrophysical implications of cosmic ray time variations. The work done by him in collaboration with his students at the research stations established at Ahmedabad, Gulmarg, Kodaikanal, Trivandrum and Chachaltaya in Bolivia (South America) led to the discovery of new solar relationship of cosmic ray variations.

For space explorations, Dr. Sarabhai strived to set up the Thumba Equatorial Rocket Launching Station (TERLS). It was commissioned in November 1963 and has earned U N. recognition.

Not content with the launching of French Centre sounding rockets obtained from abroad, Dr. Sarabhai planned a Space Technological Research Centre at Veli, Trivandrum, for the design and development of Indian rockets with indigenous pay loads, for supporting scientific instrumentation and equipment, suitable solid and liquid propellants and overall cosmic ray research in aiding our project.

The commissioning of the Sriharikota Space Station on the Andhra Coast in 1971 placed India on the threshold of the satellite era.

From Kashmir to Kerala there stand a number of institutions of learning, research and experimentation which bear witness to Sarabhai's great vision, his devotion to the cause of national advancement and his dedication to the promotion of knowledge. Sarabhai's intense concern was relationship

of science to the larger purposes of human life.

To promote science-mindedness in the young, Dr. Sarabhai set up in Ahmedabad a Community Science Centre for providing facilities to boys and girls for conducting experiments and making field studies of their choice.

He initiated the Krishi Darshan programmes for the farmers on television for quick dissemination of scientific knowledge to common man which could be used for rapid economic development.

In a country of the size of India with a low level of education, Dr. Sarabhai foresaw the tremendous potentiality of satellite communications as an educational medium. He recognised that if the message of scientific farming and family planning has to be taken to the illiterate villager it could be done most effectively through a satellite based community television network He secured the cooperation of the National Aeronautics and Space Administration (NASA) of the United States for launching such a noble project on an experimental scale. The experimental Satellite Communications Earth Station was set up at Ahmedabad and it is the second of its kind in Asia. May we hope that Science Education through it would serve as a tool for ushering social changes.

The love for humanity got him deeply interested in the problems of disarmament. He devoted considerable time and effort to the Pugwash movement as a member of the Pugwash continuing committee and convener of the Pugwash Committee.

He represented India as a member of the panel of consultant experts set up to assist the UN Secretary General in the preparation of a report on the effects of possible use of nuclear weapons and on the security and economic implications for the states, of the acquisition and further development of these weapons.

For his meritorious work and services Dr. Sarabhai was awarded the Shanti Swarup Bhatnagar Memorial Award in Physics in 1962 and the Padma Bhushan in 1966.

The Government of India had rightly chosen a man of such versatile nature and immense potentialities as the Chairman of AEC and INCOSPAR, as a member of the Scientific Advisory Committee, National Planning Council of the Planning Commission; member, governing body of the Council of Scientific and Industrial Research and the Central Advisory Board of Education.

In spite of his heavy administrative occupations, Dr. Sarabhai kept himself in the mainstream of scientific advance by frequently attending scientific meets abroad, presenting papers at conferences and contributing articles to leading scientific journals.

Dr. Sarabhai's dreams which remain to be fulfilled are :

(i) The utilisation of nuclear energy for agro-industrial complex, and

(ii) The utilisation of saline water for agricultural purposes to irrigate the desert areas of Rajasthan.

Dr. Sarabhai would remain in the annals of history, a source of inspiration for the present as well as the coming generations Let me hope some one would take up his unfinished tasks to completion.

We offer our sincere condolences to the bereaved family. The loss to them is great and the loss to the Nation is also great.

Norman Borlaug: Pioneer in the Green Revolution

DON PAARLBERG

The story of the Green Revolution begins in Mexico in 1944 when Norman Borlaug went to that country for the Rockefeller Foundation to improve its agriculture. There followed a chain of events, partly planned and partly the result of chance, that promises nothing less than the transformation of world agriculture. In 1970, Borlaug received a Nobel Peace Prize for his work.

MEXICO to which Borlaug came in 1944 was an agricultural country with three-forths of the people living on land cultivated with traditional methods. Corn yield per acre was eight bushels, compared with 28 bushels in the United States, and wheat yields were less than 12 bushels. Most farmers were illiterate. Per capita rural incomes were but a fraction of those in the cities. The numbers of people were increasing at a rate that would more than double the population in 25 years. As a consequence of population growth, the food supply was in jeopardy. Imports were rising, asserting a troublesome demand for limited foreign exchange.

Borlaug and the three other Americans with whom he started the work, coming in fresh with Foundation backing, had some enormous advantages. He was free from the political pressures which beset government efforts at agricultural development. He was not troubled by the professionalism that impedes university research There was no compulsion to show a profit, as is the case in business enterprises. Perhaps most important, Borlaug was free from that handicap of the "short-term" assignment which keeps an agricultural scientist in a country just long enough to gain some understanding of the problem but not long enough to make a major contribution.

He set up a programme with these unique features : (1) Priorities were established, *and adhered to*. The number one priority was to improve wheat yields so as to feed hungry people. (2) No distinction was masde between basic and applied science; emphasis was on whatever was needed to advance towards the programme objectives. (3) Foreign career scientists were placed in charge and given long-term assignments. Young Mexicans were trained through internships and outstanding men were given advanced study with the purpose of preparing them to take over the programme. Borlaug's idea was for the Foundation to "work itself out of a job".

Relations with the Mexican government were cordial from the first. The original venture was made at the request of government officials. Testing facilities were made available at the national agricultural college at Chapingo, just outside Mexico City. Co-operation with the government extension service began early and continued. One precaution was observed; the Mexican government must remain sufficiently distinct from the programme so that failure of some programme venture, if it occurred, would not implicate the government. And vice-versa

Only by keeping the relationship loose could the independence of the programme be assured. Good relationships were also established with other agencies: the Ford Foundation, the Food and Agriculture Organisation of the United Nations, the U.S. Department of Agriculture, and the U.S. land-grant colleges of which Borlaug was a product. But the same strict rule was followed: no ties that would restrict the autonomy of the operation.

Wheat, the Staff of Life

More people rely on wheat as their staple food than on any other crop except rice. Wheat is nutritious, palatable, low in cost, virtually free of taboos, storable, and in every way a superb weapon against hunger. If Borlaug could improve Mexican wheat, there was the chance that he might help wheat-eating people in the rest of the world. Mexico had to import 10 million bushels a year, more than half her supply. Wheat yields were abnormally low; technology was poor. Wheat varieties were numerous and enormously varied.

The first thing Borlaug did was to gather as many of the Mexican wheat varieties as possible, from various altitudes and latitudes. Altogether, some 8,500 individual head selections were made and were tested in many locations. The native Mexican wheats were generally susceptible to rust, a fungus disease that saps the vitality of the plant, clogs the passageways from root to blade, sucks out its moisture, and covers it with a growth that reduces the effective leaf surface. A field afflicted with the disease appears tarnished and "rusty", hence the name. The disease spreads by releasing tiny spores, brown, red, or yellow depending on the species, carried by the wind for hundreds of miles. One acre of well-rusted wheat may have as many as 50,000 billion of these spores. A severe case of rust can cut yields in half or even less. Only two out of Borlaug's wheat selections showed resistance to rust, and there is no assurance that a resistant variety will continue to be resistant. Rust, like wheat, may undergo mutation, and a new race may permit the rust to overcome the wheat's power of resistance.

Because of the importance of this disease, Borlaug decided to give first priority to bring rust under control So began the programme to breed wheat for rust resistance. This involves crossing or hybridizing, an arranged marriage, the manipulation of germplasm that permits the designing of plant varieties in a fashion similar to the designing of industrial products. The assumption in crossing is that the desired plant characteristics exist somewhere, perhaps masked or hidden, in some strain of wheat. The objective is to find them, lift them out, and combine them with other desired features in a new useful form. The crossing required to achieve this result is a delicate operation, performed with tweezers and magnifying glass.

The wheat that results from the first planting of a cross may look like either of the parents, or may be intermediate and look like a new variety, depending on its inheritance. When its seed is planted to produce second-generation plants, many different types may appear No two plants are identical in the second generation. The plant breeder selects the superior ones, using as his criteria such attributes as disease resistance, yield, baking quality, drought tolerance, maturity, standing ability and so on Less desirable plants are discarded. The plant breeder keeps selecting and discarding for about six or eight generations, by which time the new variety takes on

considerable uniformity. It is then increased and tested on a larger scale in various regions. The whole process takes about 10 years; if two crops a year are grown, the necessary time can be reduced by half.

Once the process of selecting and discarding has been completed, the resulting hybrid remains fixed in its genetic composition. While the crossing of wheat is difficult and delicate, the lasting results make multiplication of the new variety both rapid and low in cost. It was this character that made possible the speedy expansion of improved wheats throughout Mexico and eventually overseas. Over a period of 20 years, Borlaug and his associates made more than 30,000 of these wheat crosses and tested the results. The choice of which to retain and which to discard is in part a matter of scientific testing and in part intuition. The two Mexican lines that had shown resistance to rust were crossed with the more promising of the other lines. In addition, there were crosses with rust-resistant wheat introduced from the United States, from Kenya, from Australia, and from Morocco. Some of these crosses produced wheat that had a fairly high degree of rust resistance.

Borlaug came to the conclusion that his improved wheat should not be highly specific in its adaptation. Mexico has a multitude of micro-climates and ecological conditions. Variations in moisture, temperature, latitude, altitude, fertility and tillage practices are very great. To try to tailor a specific and different wheat for each particular circumstance would be an impossible task. So Borlaug set about to develop a limited number of wheat varieties with general rather than specific adaptation. It was this approach that permitted the rapid spread of his wheat not only within Mexico but outside the country, from Morocco to India.

Another favourable result from a mixture of good planning and good fortune was the development of wheat varieties that were non-photoperiod-sensitive, or light-insensitive Borlaug bred photoperiod-sensitivity out of his wheats. He came up with wheats that utilize the same number of days to maturity regardless of whether the hours of daylight were lengthening or becoming shorter. This was an enormous gain If wheat is light-insensitive and if moisture and temperature permit, a farmer in or near the tropics perhaps can get two crops a year, which nature never intended. And the wheat will be adapted within a latitude of perhaps 5,000 miles instead of 500.

Borlaug and his team worked hard, in a single season they made 2,000 to 6,000 individual crosses. "Some of these kernels may be gold nuggets," said Borlaug. "Find them!" In 20 years of work they created and distributed some 75 new varieties, of which four subsequently comprised the bulk of the wheat grown in Mexico. The wheat-breeding techniques used in Mexico were not designed by Borlaug. What was unique was the execution of the plan, the adherence to the goal, the depth of his commitment, and the continuity of personnel.

By 1951 it began to look as if the battle against wheat rust had been won Then suddenly appeared race 15B, a type of rust previously of little importance, which spread rapidly throughout Mexico, the United States, and Canada Race 15B was deadly to two of Borlaug's four varieties, but the other two came through well. Reliance was shifted to these varieties and the new threat passed In 1953 another variant of rust, race 139, attacked the remaining two of his established varieties. A series of new crosses, using lines carried in the wheat nursery produced the resis-

tant Chapingo 52, Chapingo 53, Bajio, and Mexe. These resisted the new rust and provided the basis for his successful uptodated varieties.

Now that this new wheat was developed, how would he get the farmers to accept it? Four years after his work began, Borlaug showed his results to the neighbouring farmers. Five farmers showed up for his first field day at his test plots in the Valle Del Yadui in Sonora Within three years there were hundreds of farmers attending his field days, and after eight years there were thousands, coming from all parts of Sonora and three neighbouring states. These were the farmers said by some to be apathetic and disinclined to change, but in fact the farmers forced Borlaug to release his wheat before he had intended when he saw them picking the heads off wheat plants in his test plots.

The Giant Dwarf

By 1957, thirteen years after his work began, Borlaug was able to say that he had the rust problem under control. A number of new lines had been released; 70 per cent of area cultivated to wheat was seeded to these new varieties. The national average yield had been increased from 11.5 to 20 bushels per acre. This was unprecedented and unquestionable success.

But yields were still low. Soil fertility was limited and the capacity of his wheat varieties to take up soil nutrients was likewise limited. Soil fertility could be increased with fertilizer But Borlaug's wheats responded by growing tall and lodging, i.e., falling flat with rain and wind rather than producing more grain A small application of fertilizer helped some, but beyond that point, the more fertilizer the lower the yield. This was true of all the Mexican varieties, which were naturally slender and inclined to be tall As in most parts of the world farmers had traditionally selected seed from plants with the highly visible attribute of tallness, associating this—often incorrectly—with vigour and productivity.

What was needed was germ plasm, from somewhere, that would permit the wheat to assimilate a large amount of soil nutrients and convert these nutrients to grain, standing stiff and erect in doing so. These attributes had to be capable of being incorporated into his adapted rust-resistant Mexican wheats. He had no such germ plasm; evidently he had to go outside of Mexico to get germ plasm capable of high nutrient intake and high yield

From Japan came this last major component of Borlaug's miracle wheat. The Japanese farmers were growing a number of remarkably stiff, short-stemmed wheat varieties. When heavily fertilized, these varieties stayed erect and gave good yields. These short-stemmed Norin wheats of Japan have as many leaves and, hence, as big a manufacturing surface per stem as the other wheats. The difference is that they have shorter intervals between the leaves. They waste less effort in erecting an unproductive stalk, and they have many more stems per plant. Furthermore, and extremely important, the Norin wheats have the capacity to take up large amounts of soil nutrients and convert them to grain.

Sixteen varieties of Norin were made available to American wheat breeders in 1947/48. Orville A. Vogel, a wheat breeder to the U.S. Department of Agriculture and the first to recognize their worth, discovered that the Norin wheats had many faults under American conditions. Vogel went to work on these defects, and eventually overcame them; he found that the short-strawed character of Norin 10 was readily trans-

ferred to the offspring when crossed with other varieties. Borlaug obtained some of early crosses and breeding lines from Vogel in 1953, crossed Vogel's wheats with his Mexican varieties, and obtained the desired adaptation: disease resistance and short straw. The increased yield potential of the new dwarf wheat was due not only to its non-lodging characteristic but also to its greater number of stems, the greater number of grains per head, and its better grain-filling qualities Furthermore, since the varieties he developed were non-photoperiod-sensitive they had wide adaptability and were capable of being grown in most of the tropical and sub-tropical wheat-producing countries of the world Growing two crops a year, Borlaug had two varieties, Pictic 62 and Penjama 62, ready for release by 1961, eight years after he first received the parent stock

Optimum nitrogen application for the old wheats had been about 40 pounds per acre; the new wheats made efficient use of 120 pounds. Increased amounts of phosphorous and potash were also needed, as were some of the minor elements. Balancing the diet for these new wheats required an immense amount of research in soil fertility and plant response, which Borlaug and his colleagues readily incorporated into the work of the Rockefeller project along with pathology and genetics. The new wheats were so prolific that all kinds of undertakings, previously unprofitable became paying practices: weed control, the use of insecticides, and additional irrigation. Borlaug moved into these areas with his research.

Once the practices were orchestrated the yields of these wheats were phenomenal. Better farmers, using improved methods were able to get yields as high as 105 bushels per acre, two and a half times as high as top yields with Borlaug's earlier varieties. In 1965, Borlaug could say, "The impact of these varieties has been so great that in four years they have taken over 95 per cent of the area cultivated to wheat in Mexico" The wheat was so attractive to farmers that virtually all of the first crop and much of the second was used for seed. National average wheat yields per acre, which had almost doubled from 1943 to 1957, increased another 50 per cent by 1963 Eleven and a half bushels per acre national average in 1943; 30 bushels per acre in 1963 From a wheat deficit of 10 million bushels, half her needs in 1943, Mexico now provided the wheat for a larger population and fed them better.

The Breakthrough

Agricultural development people throughout the world noted the Mexican success and a parade of visitors came to the project. An International Rice Research Institute, modelled on the Mexican wheat experience, was set up in the Philippines. There were several things about this breakthrough that make it special: It came in the hungry part of the world, not in those countries already surfeited with agricultural output. It came in the tropics, which had long been in agricultural torpor, not in the temperate climates where change was already rapid It produced new knowledge and technology that could be used by farmers on small tracts of land, rather than being, like many technological changes, adaptable only on large farms.

Closely built into his wheat research, Borlaug had a trainee programme resembling an apprenticeship arrangement. Over the years some 100 young scientists from 22 nations participated in his programme, learned his methods and absorbed some of his enthusiasm. They returned to their countries, often carrying the new wheat varieties with

them. These were "the wheat apostles", who laid the groundwork for the later rapid expansion of the Mexican wheats.

In India and Pakistan, agricultural practices had changed but little for centuries, as in Mexico. The two countries were experiencing more than their share of the population explosion, and had been barely meeting their food needs by increasing imports of American PL--480 wheat—a policy that could not continue indefinitely. In 1963, government officials of India and Pakistan invited Borlaug to visit their countries. At Lyallpur, Pakistan, he found a number of wheats from Mexico—brought to Asia by two Pakistani trainees who had been with him in Mexico. These two young men, Manzur Bajwa and Noor M. Chaudhry, had grown and observed these wheats at Lyallpur since 1961. The wheats looked rather ordinary; the research administrators had not permitted the rates of fertilization and cultural practices suited to them, insisting on the standardized treatment. But the young men had purposely mislabelled one of Borlaug's wheats, planted it in an obscure corner of the test plot, and applied 120 pounds of nitrogen instead of the authorized 40 pounds. The result was phenomenal.

As soon as the performance of the Mexican wheat was noted, Pakistan ordered 200 kilograms and India 300, sent by air. In 1964 these wheats were planted experimentally, in various locations in both countries. Despite poor fertility practices, results were good. A plan was developed: half the wheat would go for commercial increase to make more seed available the following year; the other half would go for demonstrations, planted in small plots by hundreds of farmers. Breeding work would go forward at the experimental farms, and there would be a step-up in the training of young scientists. India ordered 250 metric tons from Mexico in 1965 and Pakistan 350. This was to be seed stock from Mexican commercial fields, not from test plots. But as a result of improper fumigation and handling, much of the wheat had lost its ability to sprout. The Indians and Pakistanis planted the wheat at regular rates. It came up thin on the ground, an extremely poor stand, 7,000 acres in India and 10,000 in Pakistan. But each plant tillered out, sending up many stems so that at maturity it seemed almost a full stand. Amazingly, about 80 per cent of the research work done in Mexico proved to be directly transferrable to Asia.

For the 1966/67 crop, India ordered 18,000 metric tons of seed wheat from Mexico, the equivalent of two average shiploads. Together with seed from their own production, this was enough to plant 700,000 acres. The Pakistanis had enough for 600,000 acres. This was the year of the great drought on the Indian subcontinent, but the Mexican wheats did well. Under farm conditions, with proper cultural practices, they outyielded the native wheats by a factor of 2 or 3 or 4, sometimes even more. Standing three feet tall instead of four or five, they took up enormous amounts of soil nutrients and still stood erect.

Then a great debate arose in India and in Pakistan. The Mexican wheats had looked very good. Should a full and firm commitment be made to these wheats? The decision lay with the government administrators, who consulted the farmers, the extension service, the production scientists, the economists, and the sociologists. Counsel was divided. The farmers wanted the wheat, but many of the scientists were dubious about staking so much on a wheat so new, subjected to such limited testing. Suppose there should be an outbreak of some plant

disease to which the new wheats were susceptible, and the whole crop were lost? For a nation on the threshold of hunger, the margin for experimentation was too thin. The cultural practices recommended for the Mexican wheat were far beyond the experience of Asia. Where would the necessary fertilizer come from? Could farmers be taught to fertilize and irrigate properly? The Mexican wheats produced relatively little straw; how would the bullocks be fed? The colour of the wheat was red, while the Indians preferred white. Baking qualities were not the preferred ones. With abundant supplies, the price would be driven down. And so on.

In the end, the victory went to those who favoured the Mexican wheats. Pakistan imported 40,000 metric tons in 1967, enough with the seed they themselves had grown, to plant three million acres. The promotional programme was tremendous. There were demonstration plots all over the land, some 30,000 or 40,000 altogether, contrasting the native with the Mexican wheats. Weather was good and yields from these wheats were heavy. In Pakistan the new wheats occupied 20 per cent of the total wheat area and produced 42 per cent of the total crop. In India the corresponding figures were 18 per cent and 36 per cent. The total production of wheat in Pakistan exceeded the previous record by approximately one-third, bringing self-sufficiency for the first time in years. Further expansion of acreage in these wheats occurred in 1968/69 when India seeded 14 million acres and Pakistan 7 million Mexican wheat varieties are grown on an area 15 times as great as the entire area sown to wheat in Mexico only six years after the first samples, measured in grams, were received for trial.

The Mexican wheats were a stimulus for other crops Almost concurrently with their adoption came the spread of the new "miracle rice," IR-8, produced at the International Rice Research Institute in the Philippines. Like the new wheats, the new rice is short-strawed, capable of standing erect when heavily fertilized, a voracious feeder, widely adapted. The techniques for developing the miracle rice were modelled on those used by Borlaug on wheat. These two cereal grains are the backbone of the world's food supply. Both have been immensely improved and together they have touched off a transformation in the growing of crops, a "green revolution."

Excerpted from *Norman Borlaug—Hunger Fighter*. Washington (D.C), Foreign Economic Development Service, U.S Department of Agriculture, cooperating with the U S. Agency for International Development, P.A 969, December 1970, pp. 1-17.

Protein Deficiency can Cripple a Child's Brain for Life

DANIEL BEHRMAN

MALNUTRITION and particularly diets lacking in protein may affect the brain growth of young children to the point where they cannot benefit fully from education and in fact, suffer damage that lasts as long as they live

Scientists have long suspected such a link between mental retardation and inadequate protein intake, but their suspicions are now unhappily being confirmed

This was the gist of a statement made by Unesco's Assistant Director General for Science, Professor Adriano Buzzati-Traverso, at a recent meeting held at the United Nations in New York. It brought together a panel of advisors "to formulate a strategy statement on the protein problem confronting the developing countries"

The most recent research quoted by Prof. Buzzati-Traverso was carried out last year by J. Cravioto and E.R. Delicardie in Mexico. They concluded that "children who survive a severe episoda of malnutrition early in life are handicapped in developing skill in reading and writing and are less able to profit from the cumulative knowledge available to the human species in general".

These findings agree with the results of earlier work carried out in places as widely separated as Central America, India, Indonesia and Yugoslavia, on children known to have suffered from undernourishment. The tragedy is that the harm is irreversible. As Prof. Buzzati-Traverso summed up:

"The extensive evidence available from research on experimental animals, and the more limited but very suggestive data collected on samples of children who had suffered malnutrition before entering school, in various parts of the world, show that malnutrition during certain critical periods of brain development (up to ages two to three years and possible at some stage of foetal growth) may produce permanent impairment of brain structure and functions."

Even more frightful implications are to be found in the results of work reported a few months ago in the American magazine, *Science*. Three researchers from the University of California School of Medicine found that lack of protein affected not only female rats but also their offspring who also displayed lower cerebral weight despite a normal diet. The scientists, Stephen Zamenhof, Edith van Marthens and Ludmila Grauel, state: "If the results with rats have a bearing on the situation in humans, one must consider that, even after nutritional rehabilitation, a cerebral deficiency may last for at least one generation longer".

This is not a simple problem of "feeding the hungry". Prof. Buzzati-Traverso suggested that child malnutrition is not so much caused by overall food and pro-

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tein shortages as it is by "lack of awareness—by those who feed the children—of the consequences and implications of defective child nutrition".

He suggested two approaches. The first would be a research project to evaluate "anatomical, biochemical and behavioural effects of inadequate pre-school nutrition amongst children belonging to economically disadvantaged sections of society in all countries."

At the same time, he said "Authorities in charge of education in all countries should be informed promptly of the risks inherent in malnutrition during critical periods of the child's development. Ad hoc campaigns should be launched at the national level to inform teachers and parents about the problem".

Promotion Fund Called for

Finally, he called attention to a suggestion by the United Nations Advisory Committee on the Application of Science and Technology to Development for the establishment of a "protein promotion fund" and its appeal to the United Nations Development Programme to support research on the problem.

These aspects of the protein shortage—its effects on education and the need for basic research—were only two of the many that were reviewed by the panel at the meeting, which had Mr. C. Subramaniam, India's Minister of Planning, as chairman.

In the panel's final statement, it recommended a broadening of the membership of the present Protein Advisory Group sponsored by the Food and Agriculture Organization, the World Health Orgnization and UNICEF.

The statement said that its membership should include "all relevant organizations and agencies in the United Nations system" and that it should have a "highly competent technical secretariat" located in New York.

The panel pointed out that there were a number of ways available to meet the protein shortage whether through increased production in agriculture and fisheries, development of such unconventional sources as fish protein concentrates or protein production from petroleum, or better education of consumers But priorities are needed and, the panel said flatly, they must be given to saving those in danger of irreversible damage—that is, the children.

"It is ironical", the panel said, "that a society which undertakes the responsibility of training the minds of the young does not also accept the task of assuring that the nutritional and health status of its children is such as to make this training achieve its ends to the fullest."

Protein Development Tax?

A host of ideas can be found in the panel's statement. For example, it says that developing countries could pay for nutrition programmes by a "protein development tax" on such items as soft drinks, alcoholic beverages, entertainment, sources of energy, luxury travel, etc.

Another ironical aspect of the protein problem is an unexpected effect of the Green Revolution which has seen new varieties of wheat and rice literally double the cereal production of many countries. More calories are grown but, as the panel said, there has been a reduction in the area sown in protein-rich pulses and oil seeds as they are displaced by high yielding varieties of wheat and rice.

This problem could be met by a research programme to achieve a similar "Green Revolution" in other crops and also by a

manipulation of the price of pulses and oil seeds to make it more profitable for the farmer to grow them.

At the same time, more research is needed on increasing the nutritive value of cereal protein. A high-protein variety of maize does exist but its yields are lower than that of normal varieties and it is not as disease-resistant.

Around the Research Laboratories of India

Cotton Technological Research Laboratory, Matunga, Bombay

Introduction

THE Cotton Technological Research Laboratory, Matunga, was founded by the Indian Central Cotton Committee in 1924 It has helped in pioneering research on cotton fibre technology, especially on cottons grown in India. The Laboratory is housed in its own buildings in the northern part of Bombay, amidst expansive Municipal Gardens and in the neighbourhood of the educational and research institutions of the Bombay University. It has attached to it small laboratories situated at eight cotton-breeding stations in the different cotton-growing States in the country. The administrative control of the Laboratory was taken over by the Indian Council of Agricultural Research with effect from April 1, 1966.

Objectives

The main objectives of the Laboratory are: (1) to help the Agricultural Departments in evaluating the quality of new strains evolved, (2) to assist the trade and industry by furnishing true evaluation of the different trade varieties of Indian cotton, (3) to issue authoritative reports on the samples of textile materials received for test from trade, Government Departments and other sources, (4) to carry out research investigations on the physical, chemical and structural properties of cotton in relation to quality and spinning performance, on the factors involved during spinning of cotton and on the quality characters of yarns, (5) to carry out investigations on the ginning of Indian cottons, (6) to investigate the greater and better utilization of cotton, cotton waste, linters, cotton seed, etc., and (7) to disseminate technical and scientific information.

The Laboratory is equipped for carrying out different types of tests on cotton fibres, yarns and fabrics. It also has a spinning mill where cotton samples are spun under uniform comparable conditions A modernization and expansion programme is in progress

In addition to routine testing of samples received from various sources, extensive research investigations have been carried out at the Laboratory in various topics and, based on these, a large number of publications have been released. The Laboratory carries out tests for the determination of properties of fibres, yarns and fabrics, and issues authoritative reports on them for the benefit of trade and industry.

Achievements

Sample Testing: In a year more than 3,000 samples were tested and the results reported to the different cotton breeders and officers of the Agricultural Departments. Mill tests were arranged on various cotton samples

which were in the advanced stage and ready for distribution on a large scale. In addition, a large number of samples obtained from different agronomic and breeding experiments in the States were tested and technological reports on them were issued. A very large number of extra-long-staple strains have been evolved and their test results are being supplied to the breeders. It is expected that in the near future some of these varieties combining high yields with increased spinning value would be stabilized

Research Investigations : Many research projects were under investigation during the period. Some of them were completed and studies on others are being continued. A brief review on some of the projects is given below.

Investigations on the microbial decomposition of cellulose with special reference to the effect of Indian bacterial organisms on cotton and cotton fabrics were carried out under a PL 480 grant to obtain basic information for the improvement of cotton products. Another project also financed from PL 480 funds was connected with the preparation of radio-resistant and radio-sensitive celluloses to obtain basic information on the chemistry of cotton celluloses The effect of gamma-ray irradiation at different dosages on the raw as well as the chemically modified samples of cotton was studied.

In the study of structural properties of cotton by optical methods, some interesting results were obtained and these were published in the Textile Research Journal. Further, a paper entitled 'Plant cell-wall structure with special reference to cotton fibre' was presented at the Molecular Biology Sessions held at the Banaras Hindu University.

The work relating to the investigation on variation in fibrillar orientation (measured by 40 per cent X-ray angle), fibre bundle strength, D P and fibre maturity of fibres from different regions of the cotton seed was completed and the results published

To study the manner of inheritance of fibrillar orientation and strength in cotton fibres, three varieties, viz 'Bobdel', 'Cabal T-11' and 'Delfos 531 C', were chosen as suitable parents for crossing Single plant selections and the crosses obtained from these varieties were tested for fibre properties.

To find out the association between single fibre strength and bundle strength of cotton fibres at different gauge lengths, an investigation was undertaken and it was observed that the single fibre strength at 3-mm gauge length and bundle strength at 0- and 3-mm gauge lengths were highly correlated with 40 per cent X-ray angle and spiral angle. On the other hand, single fibre strength at 10-mm gauge length did not show any such significant association. A high correlation was obtained between 40 per cent X-ray angle and spiral angle. The degree of association between structural characteristics and tensile properties varied for different cottons.

As very little information was available on the effect of relative humidity on the bundle strength values at different gauge lengths, an investigation was undertaken to study the changes in fibre bundle strength with relative humidities. The data on the 12 cottons tested earlier for the bundle strength at 0- and 3-mm gauge lengths at different relative humidities were being analysed. The effect of relative humidity on the bundle strength values of chemically treated cotton was also studied.

An investigation was under progress to find out whether the existing micronaire scale was suited for the measurement of fineness of cotton belonging to different species. The data collected were being analysed.

The investigation relating to the study of changes in circularity of the fibres of various cottons when treated with caustic soda solution of different concentrations and under different tensions was completed and paper incorporating the results was sent to the Textile Research Journal for publication.

An investigation to find out the range of colour, in terms of reflectance and yellowness measured by the Nickerson Hunter Cotton Colorimeter, was under progress to determine whether any colour limits could be specified for different grades of cottons. A large number of samples of the requisite grades were being obtained through the East India Cotton Association, Ltd., Bombay, for this purpose.

An investigation was undertaken to assess the role of various structural parameters, like shape factor, number of convolutions, ribbon width, microtopography, molecular orientation and the degree of crystallinity in determining the lustre behaviour of cotton fibres. For this purpose, a lustre meter and a sample holder were fabricated at the Laboratory and number varieties of cottons were tested for various properties. The chief findings were presented in the form of a paper at the Eighth Technological Conference held at Coimbatore from December 15-17, 1966.

With the introduction of the metric system in the country, it has become necessary to standardize the method of tests, necessary experimental work was undertaken and it was concluded that skeins of 50m could conveniently be used for the purpose of determining the metric skein-breaking-strength tests, if the results are to be expressed in tenacity values.

To study the effect of certain chemical treatments on the crystallinity and some other physico-chemical properties of cotton fibres, tests were carried out on a number of chemically treated cotton samples and the results were presented at cotton technological conferences.

Major Lines of Investigation in Progress

The investigation on the inheritance of X-ray angle and fibre strength is being carried out in co-operation with the Regional Research Head of the Indian Agricultural Research Institute Centre at Coimbatore. A detailed study on the effect of agro-climatic factors on the development pattern of cotton fibres is in progress in collaboration with the Cotton Specialist at Surat.

To evolve cotton seeds with negligible gossypol content, chemical composition of cotton seeds was commenced. The method of estimation of gossypol content is being standardized.

Death by Desiccation

The problems of pollution with persistent pesticides have been so well publicised that it is perhaps surprising that more work has not been done to find ways to overcome them. A great deal of publicity has been given to biological pest control—the idea of killing insect pests not by chemical but by introducing their natural predators. But, as the Agricultural Research Council's insect physiology unit in Cambridge University's Department of Zoology is now showing, a new look at the basic physiology of insect pests can provide revolutionary new approaches to pest control rather than by the more familiar method of chemical pesticides.

Two of the scientists in the unit, Dr. Simon Maddrell and Dr. John Casida—who is now in Berkeley, California—working with very limited resources, have already found what could become a completely new approach to chemical pest control. Their research began from an investigation into the ways in which conventional insecticides kill insects—something which is surprisingly little understood, and they discovered that the overall effect of most conventional insecticides upon the nervous systems of insects is to cause the over-production of insect hormones. One such hormone is the diuretic hormone which controls the excretion of water. The Cambridge scientists found that insects could be killed by causing them to over-produce this hormone without any need for any other effect, since with their high surface area to volume ratio, insects are so specially sensitive and vulnerable to water loss

Why not, therefore, reasoned the Cambridge scientists, bypass the crude stimulation of the nervous system and use instead as an insecticide a chemical copy of the diuretic hormone itself. There is no reason, say Maddrell and Casida, why a sort of chemical model of the diuretic hormone should not be synthesised on a huge scale and used as an insecticide. It will be effective in very low concentrations because insects are remarkably sensitive to such hormones, it would quickly be broken down to harmless compounds by natural chemical processes and, since the hormones of insects are quite different to those of higher animals, it would be completely harmless to human beings, farm animals, domestic pets and so on. In all these ways it would offer considerable advantages over conventional pesticides—with the added benefit that it would be several years before the insects could evolve any substantial degree of resistance to such a new weapon.

In the laboratory next door to Dr. Maddrell, Dr. Michael Berridge is equally enthusiastic about a different means of causing death by desiccation. House-flies, he is beginning to believe, could be killed by making them dry themselves out by overproducing saliva. A house-fly feeds by pouring saliva over its food to dissolve it and then sucking up the food in solution. Dr. Berridge has been studying the detailed molecular biology of the way in which the insect's nervous system stimulates the production of saliva. He has shown that a neuro-transmitter serotonin is used. This is secreted by nerve cells and travels from them to the surfaces of

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Reprinted from *Spectrum*, 1971.

the actual salivary gland cells. On the surfaces of these cells are receptor sites, tiny sockets each the size and shape of a single serotonin molecule. When a serotonin signal is sent from a nerve cell then serotonin molecules arrive at and fit perfectly into these sockets, receptor sites, and their arrival then triggers off saliva production. Dr. Berridge has shown that this is actually a three-stage process. First as a serotonin mokecule approaches a receptor site, one part of the molecule acts as a kind of feeler directing the molecule down towards the receptor site rather like an aeroplane making a blind landing on a runway. Then the main body of the molecule settles into the socket. Thirdly, another part of the molecules acts as the actual trigger which starts salivation.

Dr. Berridge believes now that the detailed shape of both molecule and socket are known, it should be possible to manufacture molecules similar to but slightly different from serotonin which would fit into the sockets, press the trigger which started salivation, but which would never release the trigger so that the fly would go on producing saliva until death by desiccation ensued. Another approach would be to make a slightly different version of the molecule. This one would fit into the receptor sites but would be unable to start salivation. But by filling up all the receptor sites it would prevent the proper signal, serotonin, from getting through when the insect landed on food. In this way the house-fly would be prevented from producing saliva and would starve itself to death.

Dr. Berridge believes that beyond these first ideas lies the possibility of developing a whole new family of insecticides based upon chemicals designed to interfere with the action of serotonin in various different ways. Nearly all conventional insecticides operate by interfering with the action of another neurotransmitter, acetylcholine. Since serotonin is probably as improtant a transmitting subtance as acetylcholine it's certainly possible that this approach could double the chemical armoury available against the insect world.

Although all these approaches are still at the experimental stage, enough has already been achieved to justify scientists demanding that more money should be spent on basic research into insect physiology with a view to providing new approaches to the serious and growing problems of pest control.

Studying the Secrets of Haemoglobin

THE secrets of haemoglobin, the blood protein that carries essential oxygen to body tissues, are being revealed by research at the Medical Research Council's Laboratory of Molecular Biology in Cambridge. Dr. Max Perutz, Head of the Laboratory, has recently completed a model of the structure of the haemoglobin molecules. It is the result of 34 years' work by Dr. Perutz, a Nobel Prize winner for Biology.

Haemoglobin transports oxygen from the lungs and carries back carbon dioxide, but details of the process have remained a mystery. The molecule of haemoglobin is an amazing worker, though its structure is so complicated that it requires ten thousand atoms to be able to pick up two molecules—four atoms—of oxygen. One blood cell contains about 280 million haemoglobin molecules and it can carry 100 million molecules of oxygen.

Haemoglobin gets a bigger appetite for oxygen as it captures it, so that the more the process goes on the more it improves. Once it starts releasing its oxygen to tissues, the reverse happens, making this operation just as efficient. The haemoglobin expands and contracts as it works—another mystery.

Now Dr. Perutz has unravelled the way that haemoglobin operates. The oxygen is held by an iron atom which actually contracts when it captures the oxygen. This makes it small enough to be itself gripped by a ring of nitrogen atoms in the haemoglobin and held for its journey to the tissue. When the oxygen is released the iron atom expands again, the haemoglobin re-arranges itself and is ready to pick up carbon dioxide, the waste gas of breathing. At the same time it develops an affinity for hydrogen ions that neutralise the carbon dioxide and prevent the blood becoming too acidic

This work on the minute details of haemoglobin may have important effects in the treatment of blood diseases. For example, sickle-cell anaemia is a disease particularly prevalent in Africa and can cause early death. The red blood cells of sufferers distort into the curved shape that gives the disease its name and they are unable to carry oxygen properly. The defect originates in a group of atoms in the haemoglobin whose position is now precisely known. It may be possible to find a drug which blocks off this group completely.

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World Adopts Atomic Time

LONDON's famous Big Ben and timepieces throughout the world will be governed by atomic time instead of astronomical time when a new reference standard is adopted on January 1, 1972.

From that day time signal transmissions will correspond with an internationally agreed time scale derived from atomic clocks, the most precise of all measuring instruments The first atomic clock was developed by Britain's National Physical Laboratory in 1955 followed by separate developments in the U.S A. and Canada.

The worldwide adoption of atomic time in radio and television broadcasts will facilitate the operation of precise time synchronisation necessary in satellite tracking, radio-astronomy and high-speed communications.

In everyday time keeping the effect of the change will be small, amounting to about one second a year Two atomic clocks, one at the National Physical Laboratory and the other at Rugby in central England, will set the pattern of British time keeping.

Part of the National Physical Laboratory's work as a standardising laboratory is to establish and maintain primary standards of time. To this end the first atomic clock was successfully developed by the Laboratory to replace the previously well established quartz crystal clock.

From experience gained with this equipment, a new clock was designed in 1957, a basic idea of which was that it should define frequency and a unit of time 10 times more accurately than the prototype model, This objective was achieved by perfecting a timepiece with a standard of accuracy of about half a microsecond a day—equivalent to one second in 150,000 years.

Courtesy: British Information Services.

A Cheap Substitute for Granulated Zinc

S. D. CHOUDHRY

ONLY a month back, I, at the invitation of an old student of mine, visited his Aluminium Works at Jagadhri. While we were at tea, I found the labourer were throwing a black dust like powder outside on the road as waste. My host told me that they were anxious if that rejected dust could be put to some practical use. I felt interested; they had extracted aluminium from the factory waste and the ash in the form of black powder was being thrown away. I sent for hydrochloric acid. I added acid over a few grams of the dust waste. Hydrogen came out copiously for a long time. Now this aluminium waste is very cheap and can be had by paying a rupee or so for a quintal. Therefore, this waste can be used for the commercial preparation of hydrogen gas at a very low price. It is high time we in India substitute granulated zinc with aluminium waste dust which is so economical. Aluminium reacts with hydrochloric acid to produce aluminium chloride and hydrogen. Sulphuric acid reacts with it to form aluminium sulphate and hydrogen. Both these salts are of commercial importance. Why waste national resources by purchasing costly zinc when a cheap substitute is available?

Explosives to Control Algae Growth

SCIENTISTS at a Welsh University believe they have discovered a cheap and effective method of controlling algae growths which threaten to turn lakes and reservoirs into "green pea soup".

Using explosive devices, biologists at the University of Wales, Institute of Science and Technology under Prof. R.W. Edwards have been able to create shock waves. The waves cause the buoyancy bags, which keep the algae afloat, to burst, and the algae to sink to the bottom.

This technique has been successfully tried out on a reservoir feeding the works of the British Steel Corporation at Port Talbot. The reservoir had become so thick with algae that it was seriously affecting the production of high grade steel.

Prof. Edwards said his team used cordtex, which is manufactured by Imperial Chemical Industries, to create the explosion. The best method of doing it was to roll it into balls and sink them at different points in the lake and detonate them all together This method minimised the effects on fish.

Courtesy: British Information Services.

Fighting Air Pollution

DIRECT methods of fighting harmful discharges are unfortunately not always effective. Every thermal electric power station burns hundreds of tons of fuel a day. The gas, forming during coal burning, at first sight has low sulphur content—only 1-4 per cent—but the net quantity of discharge is immense. At large stations up to 95 per cent of ash can be trapped, but 5 per cent (and this is quite a lot) can get into the atmosphere. Therefore, the only way out, so far, is to build high smoke stacks: with the growth of the height of the smoke stacks from 10 to 100 m the concentration of toxic gases in the near-ground air layers

falls by 100 times, and this means 99 per cent cleaning effect.

Only 5-10 years ago the smoke stacks of thermal electric power stations in the USSR were 120-150 m high, and now the figure has reached 180--250 m, and smoke stacks of up to 320 m are being designed. Yet, it is by far not always feasible to increase the height of smoke stacks—it is much more sound and cheaper to learn to forecast the development of a dangerous weather situation. In Leningrad, the first experiment of this kind recommended in case of unfavourable weather forecast to transfer city boiler rooms to reserve fuel—gas.

Thus, air pollution must be fought with all the means available. Installation of powerful filters, construction of high smoke stacks, change-over to comparatively harmless type of fuel, reduction of discharge intensity in periods of unfavourable weather, introduction of electric cars instead of automobiles—such are the ways of fighting for clean air. This is a job in which meteorologists must also be enlisted, and they are always ready to help

Courtesy: Soviet Features.

Choosing Sex

Many scientists who have considered the question feel that it may be better for the human race if it never finds an effective way of being able to select the sex of its offspring Upsetting the natural one-to-one ratio of boy to girl could have disastrous consequences. None the less, for better or worse, it is a development which is very likely to come.

At present, it is possible to predict the sex of children only by sampling the aminotic fluid which surrounds an unborn foetus and examining the genetic constitution of cells which have leaked into the fluid from the embryo. But this method is of little use unless the parents are willing to have the foetus aborted if the sex is not the preferred one So as to decide sex before conception, some means has to be found to separate the kind of sperm which gives rise to a male from that which gives rise to a female. In the human, the sex of the offspring is determined by the father not mother; so, in order to choose the sex of children, male and female sperms have to be effectively separated before fertilization.

Over the past several years, there have been a number of reports that this separation has been successfully performed but none of them have been confirmed. The difficulty is that the difference between a male producing sperm and a female producing sperm from the same man is very slight. The only genetic difference between males and females is found in one pair of the numerous chromosomes in every human cell. In the male, one member of this pair is a big chromosome called the X chromosome, the other is a smaller one with a distinctive shape called the Y chromosome. In the female, both members of the pair are X chromosomes. Some people believe that it is possible to separate the two by centrifuging a sample of sperm for a long time, when the male and female producing sperms will separate because the male sperm is minutely lighter owing to the presence of smaller chromosome. But separations carried out so far have only provided semen with a higher proportion of one type than the other, which can be used to provide a better chance of producing one sex or the other, but nothing like a certainty.

Other methods, however, are being tried to separate male and female producing sperms. The thing most urgently needed is some means

of testing just how efficient such separations really are. And this is exactly what has now been provided by a team of scientists at Guy's Hospital, London, the Medical Research Council's Population Genetics Unit, and the Oxford Botany School. They have shown that a chemical commonly used to treat malaria, quinacrine dihydrochloride, stains the human male sex chromosome, the Y chromosome, brightly, but does not stain the rest of the genetic material nearly so brightly. Testing with the stain provides a quick, simple and utterly reliable technique for identifying maleness in any human cell, that is to say, any cell which stains brightly must come from some part of a human male's body.

Unfortunately, it is unlikely that the stain can be used to sort out male human sperm for subsequent artificial insemination with a view to ensuring the birth of male children only. The scientists fear that the use of the dye will kill the sperm or at least inactivate them. However, there is a chance that this may not be so Quinacrine dihydrochloride has so far only worked with human cells. It has not distinguished the Y chromosomes in any of the animal cells tested with it so far So, there is no immediate application for the technique in agriculture, where farmers are so often anxious to produce female rather than male offspring. None the less, by showing straightaway how effective any other technique has been in separating the sexes, staining the Y chromosome brings the day much nearer when we can select the sex of our children or our domestic animals.

It is also going to be valuable to psychiatrists concerned with violent criminals. Recent British research has shown that male children born with a genetic deformity, which gives them an extra Y chromosome in every cell, tend to be predisposed towards criminal violence. The new stain can reveal the presence of an extra Y chromosome straightaway, in a simple test applied to a tissue sample scraped painlessly from the inside of the cheek. A test like this is exactly what psychiatrists need, faced with a violent criminal or a young boy showing worrying behaviour patterns, which could be linked to an extra chromosome

Finally, the team has discovered that other parts of the genetic material, although they are dyed much less strongly than the Y chromosome, are actually dyed differently in different individuals This difference reflects one kind of genetic difference and it could open up a completely new and valuable field in genetic research.

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Super-conducting Filaments

Many new ways have been found during the past few years of exploiting the phenomenon of superconductivity—the property possessed by a few materials of completely losing their resistance to the passage of an electric current when they are cooled down to near absolute zero. One of the most important of these is in super-conducting magnets. If the coils of a magnet can be made super-conducting then this allows of the construction of extremely powerful magnets, in much smaller sizes, requiring far lower voltages

SUPER-CONDUCTING magnets are finding a variety of important uses, and if these are to be extended, more and more advanced super-conducting alloys are needed. The difficulty lies in producing super-conducting wires with which to make the windings of the magnet. The British Cryogenics Council, which exists to promote research and development into the properties

of materials at very low temperatures, has recently awarded the first of what is to be a new series of annual prizes to a British team which is developing super-conducting wires. The winners are two young scientists, Mr. M N. Wilson of the Rutherford High Energy Laboratory, and Mr. E.C Barber of Imperial Metal Industries

Mr. Wilson and Mr. Barber began their collaboration in a project to design a super-conducting magnet for the United Kingdom's particle accelerator (atom smashing machine) known as NIMROD, at the Rutherford Laboratory. No super-conducting magnet has yet been installed in a particle accelerator, but undoubtedly in the future they will be, because more powerful magnets are required to focus and direct the beams of atomic particles used in such machines.

The world's most powerful particle accelerator, the so called 'Big Machine' which is to be built for CERN at Geneva, is being designed to incorporate super-conducting magnets and eventually as many as 1000 such magnets may be required for this machine. And almost certainly the windings of these magnets will come from Mr. Barber's laboratory at Imperial Metals

These wires are made of microscopically fine filaments of niobium and titanium, each strand wrapped in cupronickel, and embedded in bundles in a copper matrix. The finer the filament, the better. On a production scale Imperial Metals have made filaments down to five microns in diameter; on a laboratory scale they have managed to achieve about half a micron.

The reason why such tiny filaments are needed is that super-conductivity is a very unstable state. A small change in the temperature or current or magnetic field, all affect the properties of one filament. But if this filament is very fine and isolated from the others, then the overall effect will be unimportant. None the less, changes in the properties of one filament can affect the others to some extent. But even this can be cancelled out, by twisting the filaments round each other—a difficult piece of technology at this order of magnitude, but one recently achieved by Imperial Metals.

Super-conducting filaments are, of course, finding use in fields besides atom-smashing. Those made by Imperial Metals are incorporated in the super-conducting electric motor, built by the International Research and Development Corporation (IRD) which is now driving a pump in a large power station at Fawley. Many more such motors will be bluit in the future, and super-conductors will find their way into the huge electrical generators of the future, each single one able to supply 2000 megawatts, enough power for 2½ million people. One of the most immediate markets, Imperial Metals believe, will be in marine propulsion, where the use of super-conductivity in generators and motors can cut down the size and weight of the plant enormously.

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NCERT at the National Science Exhibition for Children

THE Department of Science Education of the NIE participated in the National Science Exhibition held at National Physical Laboratory of India and Bal Bhavan from Nov. 14-22, 1971.

The suggestion for the Science Exhibition, first of its kind, came from the Jawaharlal Nehru Memorial Fund. The task of organising was entrusted to the National Council for Science Education (NCSE) in close cooperation with the Council for Scientific and Industrial Research (CSIR), the National Council of Educational Research and Training (NCERT) and the University Grants Commission (UGC).

The Exhibition was declared open by the President of India, Shri V.V. Giri, on Nov. 14, 1971.

In his welcome address, Dr. D.S. Kothari, Chairman, UGC, said, the purpose of the Science Exhibition was:

(i) to popularise science through its promotion and dissemination;

(ii) to show to common man that science is interesting (it is exciting, relevant, creative and humanistic) through creative work of institutions;

(iii) to show the best of a participating institution;

(iv) to illustrate the basic principles of science through simple models;

(v) to provide a teacher, knowledge about teaching aids which help in communicating science to people without gross distortion and misrepresentation;

(vi) to show improvisations exploiting fully simple devices;

(vii) to provide information, in the context of the poor nature of our country, about the use of easily available materials, import substitutes and local resources, and

(viii) to provide an opportunity to those who are stuck up with some problem, an opportunity to learn from one another's experience.

For three months, i.e. from the middle of August '71 to the middle of November, 71, energies of the Department of Science Education were directed towards the preparation and finalization of new exhibits keeping in view the purposes outlined above and particularly the illustration of basic principles of science. A large number of these exhibits were drawn from all the four groups of the department namely—Physics, Chemistry, Mathematics and Biology.

The credit of shaping some of the proposals and blueprints to demonstration or working models goes to the Central Science Workshop.

The exhibits were screened by an expert committee sent by NCSE and UGC and finally by Prof. S.V.C. Aiya, Director, NCERT. The four guiding criteria in screening were

(i) eye catching nature of the exhibits (ii) possibility of a continuous display (iii) lasting for the tenure of the exhibition, and (iv) not much expensive in operation. Based on the above criteria 30 exhibits were selected for display, about two-thirds of which were exhibited at Bal Bhavan and one-third at the National Physical Laboratory. Besides the new exhibits, primary and middle school science kits and textual materials for schools produced by NCERT were also displayed. The textual materials included textbooks, teachers guides, supplementary readers, study group materials and laboratory manuals.

Some of the popular exhibits were electrons at work, see your voice, hydraulic balance, rotating chair, ping-pong ball supported on cushion of air, blood pressure measuring apparatus, bulb lighting by itself, non-bursting of balloons on hitting, salvaging a sunken ship, a battery operated electromagnet, rotational and string models of some geometrical solids, muscle contraction, DNA model, rope that is not destroyed on burning, artificial snow fall, separation of the constituents of different inks by paper chromatography, working model for the preparation of hydrochloric acid by burning a mixture of hydrogen and chlorine, distillation of petroleum, welding by thermite process, and conversion of energy from one form into the other.

To ensure whether or not the visiting school children were understanding the basic principles underlying NCERT exhibits, a quiz was organized in which children were required to answer questions based on the exhibits. Those who secured 80% or more were given an attractive prize, a sun dial produced by NCERT, showing that the shadow of an object in front of the sun can be a measure of time.

There was a great rush of visitors to NCERT pavilions. Some of the important dignitaries who visited our pavilion were : the President of India, Shri V.V. Giri, Honourable Prime Minister, Mrs. Indira Gandhi, Honourable Minister of Tourism and Aviation, Shri Karan Singh, Honourable Deputy Minister of Education, Prof. D.P. Yadav and Dr. D.S. Kothari, Chairman, University Grants Commission. The innovations in our science kits, science and mathematics models as an aid to teaching were highly appreciated.

A keen interest was evinced in the science kits. Many, who saw, were eager to purchase them for their schools.

We might have lost in sophistication but if simplicity and comprehension at school level were a criterion we were certainly leaping in the exhibition. It may also be mentioned that our impact would have been greater had not the organizers suggested to us to display the exhibits at the two different places. We have gained a lot of experience and we hope to be still better in future.